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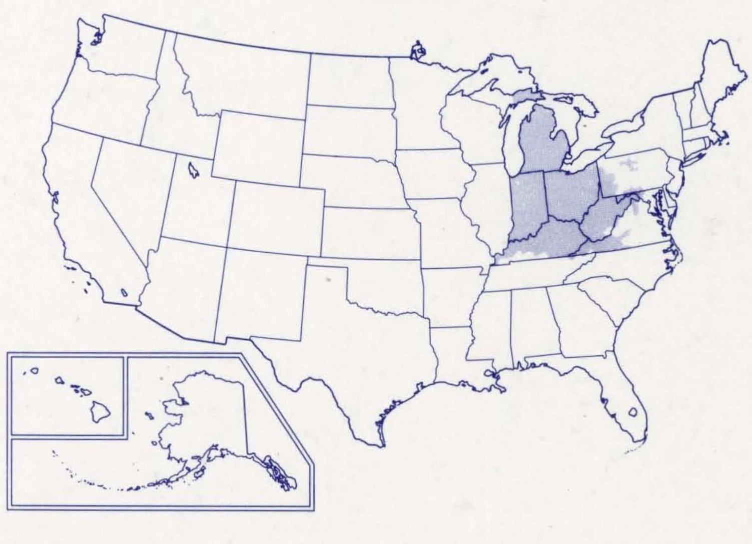
Volume XVII
September 1981

Regional Assessment: East Central Area Reliability Coordination Agreement



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This volume briefly describes existing conditions (physical, social, economic) affecting electric supply and demand in the East Central Area Reliability Coordination Agreement. It discusses the existing electric energy system and the role of hydropower therein. Projections of electrical supply and demand through the year 2000 are discussed. The hydropower resources, developed and undeveloped, of the region are evaluated and a regional ranking of specific projects and sites which are recommended to be studied in further detail is presented. The public involvement in the planning process is described.

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U.S. ARMY CORPS OF ENGINEERS

NATIONAL HYDROELECTRIC POWER RESOURCES STUDY
REGIONAL REPORT: VOLUME XVII

EAST CENTRAL AREA ELECTRIC RELIABILITY COUNCIL

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PREFACE

The economic success and standard of living in this country have been achieved, in part, at the expense of abundant supplies of low cost, non-renewable, energy sources. In recent years however, diminishing reserves of the preferred non-renewable energy sources, i.e. oil and natural gas, have prompted a national energy policy which emphasizes conservation and the development of new and renewable sources of energy. This report is a direct result of the national energy policy as it focuses on our major existing renewable energy resource, hydroelectric power.

Congress, in the Water Resources Development Act of 1976 (P. L. 94-587), authorized and directed the Secretary of the Army, acting through the Chief of Engineers, to undertake a National Hydroelectric Power Resources Study (NHS). The primary objectives of the NHS were (1) to determine the amount and the feasibility of increasing hydroelectric capacity by development of new sites, by the addition of generation facilities to existing water resources projects, and by increasing the efficiency and reliability of existing hydroelectric power systems; and (2) to recommend to Congress a national hydroelectric power development program.

The final NHS report consists of 23 volumes. Volumes I and II are the Executive Summary and National Reports respectively. Volumes III and IV evaluate the existing and projected electric supply and demand in the United States. Volumes V through XI discuss various generic policy and technical issues associated with hydroelectric power development and operation. Volumes XII and XIII describe the procedures used to develop the data base and include a complete listing of all sites. Volumes XIV through XXII are regional reports defined by Electric Reliability Council (ERC) regions. The index map at the inside back cover defines the ERC regions. Alaska and Hawaii are presented in Volume XXIII.

This volume, number XVII, describes the hydroelectric power potential in the East Central Area Electric Reliability Council (ECAR) region. A map depicting all sites described in the text is located in the jacket, inside back cover.

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Chapter 1
REGIONAL OBJECTIVES

This report presents the results of a study of the potential for hydroelectric power development within the East Central Area Reliability Coordination Agreement (ECAR) region. The study was undertaken to define the future demand for hydroelectric power to the year 2000 within ECAR and to assess the region's potential for developing hydroelectric generating facilities to meet this future demand.

Within these general objectives, this report also outlines a regional plan for future hydropower development which achieves the following specific objectives:

- Identifies all hydroelectric potential which is economically viable and regionally acceptable in terms of social, economic, and environmental impact;

- Emphasizes early development of hydroelectric additions to existing projects where such facilities can be developed and operated to curtail use of scarce and expensive fossil fuels which are currently being used to meet peak demands for electric energy;

- Maintains satisfactory performance levels for vital services already provided by a project such as flood control, water supply, navigation and base flow stabilization; and

- Insures that existing public utilization and environmental values of project lands and waters are not significantly disrupted or degraded on a long term basis.

Chapter 2
EXISTING CONDITIONS (Reliability Council Profile)

2.1 ECAR REGIONAL BACKGROUND

The ECAR power planning region is one of nine regional groups of power suppliers serving the United States and parts of Canada. The region extends over an area of nine states including all of Ohio and Indiana, Michigan's lower peninsula, all but a small portion of the states of West Virginia and Kentucky, significant parts of Pennsylvania, Maryland, and Virginia and a small area in and around Kingsport, Tennessee. Figure 2.1 is a map of the ECAR region.

ECAR is an established membership of 26 bulk power systems whose generation and transmission facilities have a significant impact on the reliability of the interconnected bulk power network in the area. An ECAR liaison committee provides representation for approximately 370 cooperatives, municipalities, and investor-owned systems. The 26 bulk power systems of ECAR are grouped under six formal power pools whose members own approximately 90 percent of the generating capacity in the area. The six power pools and pool power systems members are as follows:

APS-Allegheny Power System Sub-Region

Monongahela Power Co.
Potomac Edison Co.
West Penn Power Co.

AEP-American Electric Power System Sub-Region

Appalachian Power Co.
Indiana and Michigan Electric Co.
Kentucky Power Co.
Ohio Power Co.

CAPCO-Central Area Power Coordination Group Sub-Region

Cleveland Electric Illuminating Co.
Duquesne Light Co.
Ohio Edison System
Pennsylvania Power Co.
Toledo Edison Co.

CCD-Cincinnati Columbus Dayton Group Sub-Region

Cincinnati Gas and Electric Co.
Columbus and Southern Ohio Electric Co.
Dayton Power and Light Co.

Figure 2.1

ECAR

KY-IND-Kentucky Indiana Group Sub-Region

East Kentucky Power Cooperative
Indianapolis Power and Light Co.
Kentucky Utilities Co.
Louisville Gas and Electric Co.
Northern Indiana Public Service Co.
Ohio Valley Electric Corp.
Public Service Co. of Indiana
Southern Indiana Gas and Electric Co.
Indiana Kentucky Electric Corporation

MECS-Michigan Electric Coordinated Systems Sub-Region

Consumers Power Co.
Detroit Edison Co.

2.2 PHYSIOGRAPHY

From west to east across the ECAR region, there are six different physiographic regions with varying topographic characteristics. They are the Central Lowlands, the Interior Low Plateaus, the Appalachian Plateau, the Ridge and Valley, the Blue Ridge, and the Piedmont. The physiographic features of ECAR vary significantly from the flat to gentle rolling relief of the Central Lowlands Region to the mountainous Blue Ridge Region where Mount Rogers, elevation 5720 feet msl, the highest altitude within ECAR, is located. These physiographic regions play an important role in determining the potential for hydropower.

2.3 NATURAL ENERGY RESOURCES

Figure 2.2 illustrates the distribution of energy production related mineral resources in ECAR. As shown, this region has extensive coal deposits. The coal resources are used extensively for electric power production. The ECAR area encompasses a major portion of the Appalachian coal fields. Appalachian coals generally have a high-sulfur content and require the use of scrubbers or the treatment of coal before combustion to satisfy environmental standards.

2.4 CLIMATIC CONDITIONS

Climatic conditions affecting hydropower vary considerably over the region. Mean annual precipitation ranges from a low of 30 inches in the northern part of ECAR to a high of around 50 inches in the mountainous eastern part of the region. Most of the region averages about 40 inches of precipitation per year.

Seasonal variations in precipitation occur. ECAR averages 110 to 165 days per year with precipitation of .01 inches or more. This figure is lowest in the west and highest in the east. The wettest month of the year for most of ECAR is May or June when 4 to 8 inches of precipitation is received. October and November are generally the driest months when most of ECAR has less than

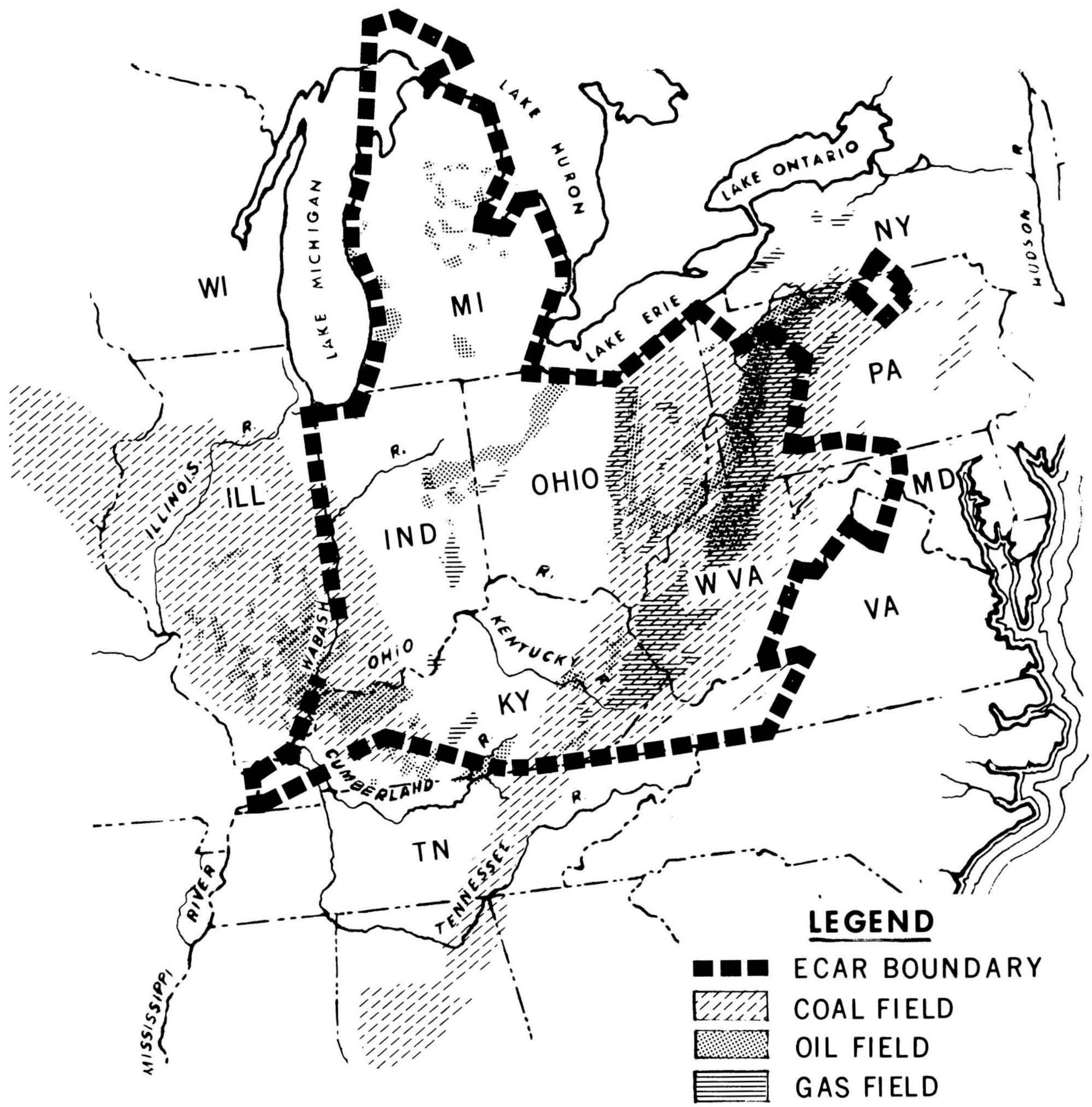


Figure 2.2

ECAR

NATURAL ENERGY RESOURCES

four inches per month of precipitation and some areas less than two inches per month. The exception to this pattern is in the northern portion of the region which usually receives the least precipitation in February when snowfall may be great but water equivalency is less than other months.

Most of ECAR experiences an average annual runoff rate of 10-15 inches. This figure increases to 25-30 inches in the mountainous eastern portions of the region. Runoff is concentrated throughout the region from February through May.

2.5 EXISTING DEMOGRAPHIC AND ECONOMIC CONDITIONS

Table 2.1 summarizes the significant demographic and economic data for the ECAR region and its six major power pool sub-regions. These demographic and economic data are for the region and its sub-regions as approximated by Bureau of Economic Analysis (BEA) economic areas. A summary of BEA areas approximating the sub-regions within ECAR is as follows:

Allegheny Power System--19, 65, 66;
American Electric Power System--20, 51, 52. 64, 76;
Central Area Power Coordination Group--67, 68 70;
Cincinnati-Columbus-Dayton Group--62, 63, 69;
Kentucky-Indiana--53, 54, 55, 56, 59, 60,61, 75;
Michigan Electric Coordinated System--71, 73, 74.

The population of the ECAR region has been gradually increasing since 1950 at an average annual rate of 1.1 percent, slightly slower than the U.S. population growth rate of 1.5 percent. In 1950, the ECAR population was 17.8 percent of the national total, but only 16.5 percent of the national total in 1970. In 1970, the Michigan Electric Coordinated System with a population of 8,200,000 (about 25 percent of the ECAR population) was the largest single ECAR sub-region in terms of population. In addition, the Michigan sub-region also had a high population growth rate of 1.7 percent between 1950 and 1970. The Central Area Power Coordination Group and the Kentucky-Indiana sub-region each contained about 18 percent of the 1970 ECAR region population.

The industrial sectors of manufacturing and trade represented important sources of earnings and income in the ECAR region. Together the manufacturing and trade sectors produced about 55 percent of the region's earnings. However, ECAR's manufacturing and trade earnings were not growing as fast as national totals, representing shrinking shares of the national market. The mining industry is of particular interest, since it represented a large share of the national total earnings. Earnings in the ECAR based mining industry represented 25 percent of the national mining industry earnings during 1970. Overall, the ECAR region total earnings grew at 3.5 percent annually between 1950 and 1970, but ECAR's share of national total earnings was decreasing.

The Michigan and the Central Area Power Coordination sub-regions produced the largest share of the ECAR region's manufacturing and trade earnings. The Cincinnati-Columbus-Dayton sub-region was also dependent upon manufacturing and trade as an important source of income. In addition to the manufacturing and trade sectors, the government sector supplied a significant portion of the earnings in the Kentucky-Indiana sub-region. Mining was important in the Allegheny and American Electric Power sub-regions. Together, they produced 74 percent of the mining earnings originating in the ECAR region, or about 18 percent of the national mining total.

Table 2-1
ECAR ECONOMIC INDICATORS 1970

Sector Earnings 1/ (Million $)	APS	AEP	CAPCO	CCD	MECS	KY-IND	ECAR
Agriculture	115	269	246	221	286	669	1,805
Mining	452	586	83	15	42	232	1,410
Construction	734	803	1,098	556	1,360	935	5,486
Manufacturing	4,040	4,267	7,782	3,722	10,718	5,552	36,080
Transportation and Utilities	892	959	1,194	575	1,313	996	5,929
Trade	1,668	1,899	2,818	1,425	3,782	2,389	13,982
Finance	394	479	638	356	913	647	3,427
Services	1,607	1,548	2,359	1,197	3,204	1,815	11,730
Government	1,299	1,733	1,765	1,370	3,295	2,323	11,785
Total Earnings (Million $)1/	11,201	12,542	17,982	9,437	24,914	15,557	91,634
Population (Thousands)	4,461	5,426	6,102	3,336	8,189	6,026	33,539
Per Capita Income ($)1/	3,215	2,887	3,623	3,498	3,718	3,153	3,376
Per Capita Income Relative to the U.S.	0.925	0.831	1.042	1.006	1.070	0.907	0.971

1/ Constant 1967 dollars

Reference: U.S. Department of Commerce, Bureau of Economic Analysis, "1972 OBERS Projections," Regional Economic Activity in the United States, Series E Population.

Per capita income in the ECAR region is expected to increase at an annual rate of 2.6 percent until 1990, then at 2.9 percent to the year 2000. Differences occur between the ECAR sub-regions. The American Electric Power sub-region is projected to have the lowest per capita income in ECAR, $4,000 in 1980 and $7,200 in 2000. By contrast, the Michigan Electric Coordinated System is projected to have one of the highest per capita incomes of the nation, $5,150 in 1980 and $8,700 in 2000. The four other subregions are expected to maintain their per capita income at about the national level of $4,780 in 1980 and $8,165 in 2000.

Table 2-2
PROJECTED POPULATION, INCOME AND MAJOR SECTOR EARNINGS (OBERS)
(EARNING AND INCOME IN CONSTANT 1967 DOLLARS)

EAST CENTRAL AREA RELIABILITY COORDINATION AGREEMENT (ECAR)

	YEAR			
Sector Earnings (Million $)	1980	1985	1990	2000
Agriculture	2,015	2,076	2,138	2,374
Mining	1,718	1,865	2,025	2,374
Construction	8,162	9,513	11,091	15,075
Manufacturing	51,119	58,649	67,334	89,277
Transpo Utilities	8,627	10,080	11,784	16,236
Trade	20,309	23,379	26,924	36,395
Finance	5,940	7,264	8,888	13,103
Services	20,971	26,149	32,611	49,927
Government	18,276	22,297	27,211	40,020
Total Earnings (Million $)	137,147	161,399	190,017	264,830
Total Personal Income (Million $)	171,310	202,858	240,320	338,209
Total Population (Thousands)	36,601	38,061	39,917	41,852
Per Capita Income ($)	4,681	5,330	6,069	8,081
Per Capita Income Relative to U.S.	.98	.98	.98	.98

NOTE: Sum of Sector earnings may not equal the total because of discrepancies in OBERS data.

Table 2.1 also shows 1970 per capita income and per capita income relative to the United States for ECAR and the sub-regions. Allegheny Power, American Electric Power and the Kentucky-Indiana sub-regions had the highest average annual growth rates of 2.6, 3.0, and 2.9 percent respectively for the period between 1950 and 1970. However, the same power system areas had the lowest 1970 per capita income with respect to the Nation. The Cincinnati-Columbus-Dayton Group, Central Area Power and the Michigan Electric sub-regions each had per capita income higher than the U.S. and ECAR averages, but were experiencing average growth rates less than the ECAR average.

2.6 PROJECTED DEMOGRAPHIC AND ECONOMIC CONDITIONS

Table 2.2 summarizes the significant demographic and economic data for ECAR projected through the year 2000. Table 2.3 provides projections for ECAR's sub-regions. Projections are based on the 1972 OBERS projections referenced in Table 2.1.

The population growth of ECAR is projected to slow from the historical average annual growth rate of 1.1 percent between 1950 and 1970 to an annual growth of 0.7 percent between 1980 and 2000. The ECAR population is expected to increase from 25 million in 1977 to about 42 million in 2000 representing 16 percent of the total U.S. population. Breakdown by sub-regions is shown below.

Sub-region	Percent of ECAR Population 1970 (%)	2000 (%)
APS	13.3	11.4
AEP	16.2	16.3
CAPCO	18.2	17.5
CCD	9.9	10.1
KY-IND	18.0	19.5
MECS	24.4	25.2

Total earnings in the ECAR region are expected to grow at an average annual rate of 3.3 percent during the study period. The ECAR earnings in constant 1967 dollars are expected to increase from $90 billion in 1970 to $265 billion in 2000. However, the ECAR share of national earnings is decreasing from 18 percent in 1970 to an estimated 16 percent in 2000. The manufacturing sector has the largest growth rate. Individual sub-region sectoral earnings are generally projected to follow the same patterns of growth as the overall region sectoral earnings. The Michigan Electric Coordinated System has the largest share of the ECAR earnings. Allegheny Power System and Cincinnati-Columbus-Dayton Group each represent the smallest shares, 10 percent of the regional total earnings.

Table 2-3
PROJECTED ECONOMIC AND DEMOGRAPHIC DATA BY SUB-REGIONS

	Total Earnings (Million $)	Total Personal Income (Million $)	Total Population (Thousands)	Per Capita Income ($)	Per Capita Income Relative to U.S.
1980					
APS	15,813	20,628	4,597	4,487	.94
AEP	19,086	24,134	6,025	4,006	.84
CAPCO	26,384	32,805	6,578	4,987	1.04
CCD	14,050	17,627	3,633	4,852	1.02
KY-IND	24,126	29,700	6,757	4,395	.92
MECS	37,687	46,417	9,010	5,151	1.08
1985					
APS	18,178	23,807	4,649	5,121	.94
AEP	22,692	28,845	6,266	4,604	.85
CAPCO	30,616	38,327	6,776	5,657	1.04
CCD	16,586	20,936	3,797	5,514	1.02
KY-IND	28,937	35,877	7,137	5,027	.93
MECS	44,390	55,067	9,437	5,835	1.07
1990					
APS	20,903	27,486	4,703	5,845	.95
AEP	26,999	34,503	6,522	5,290	.86
CAPCO	35,531	44,782	6,979	6,416	1.04
CCD	19,580	24,865	3,968	6,266	1.02
KY-IND	34,717	43,352	7,541	5,749	.93
MECS	52,287	65,331	9,884	6,610	1.07
2000					
APS	28,197	37,306	4,751	7,852	.96
AEP	38,059	49,044	6,842	7,168	.88
CAPCO	48,677	61,980	7,310	8,479	1.04
CCD	27,381	35,107	4,231	8,298	1.02
KY-IND	49,619	62,657	8,153	7,685	.94
MECS	72,896	92,114	10,565	8,719	1.07

Table 2.4 provides 1976 energy consumption by consumer categories for several sub-regions.

Table 2-4
ECAR CONSUMPTION BY CONSUMER CATEGORIES
1976 (% OF TOTAL)

Sub-Region	Rural and Residential	Commercial	Industrial	Others	Total
AEP	24.6	12.5	45.9	16.0	100.0
APS	28.2	15.0	52.8	3.0	100.0
CAPCO	25.1	22.7	47.0	5.2	100.0
CCD	34.8	23.2	31.1	9.9	100.0

Source: Reports to the Ohio Power Siting Commission, April 1977.

Noteworthy is the wide variation in industrial consumption among the 4 sub-regions for which data was reported.

Chapter 3
ELECTRIC ENERGY DEMAND SUMMARY

3.1 HISTORICAL DEMAND

Annual demand for electric energy during the period 1965-1979, for ECAR is shown in Table 3.1.

Table 3-1
ECAR ANNUAL ENERGY, PEAK DEMAND

Year	Thousands of GWH	Annual Growth Rate %	Peak (GW)	Annual Growth Rate %
1965	180.5		31.1	
1966	207.9	15.2	33.9	9.0
1967	215.6	3.7	35.1	3.5
1968	231.7	7.5	38.4	.4
1969	240.0	3.6	39.0	1.6
1970	262.0	9.2	43.0	10.3
1971	274.0	4.6	46.0	7.0
1972	299.0	9.1	49.0	6.5
1973	325.0	8.7	55.0	12.2
1974	324.0	(0.3)	53.0	(3.6)
1975	321.0	(0.9)	55.0	3.8
1976	327.2	1.9	56.9	3.5
1977	347.2	6.1	59.5	4.6
1978	350.5	1.0	59.0	(.8)
1979	359.7	2.6	60.0	1.7
Average		5.1		4.3

NOTE: Excludes liaison members, liaison membership is discussed on page 2-1, paragraph 2. Data for liaison members usage is not available prior to 1977.

Annual demand in ECAR increased steadily from 1965 until the oil embargo year of 1973 when total demand declined from 325,00 GWH in 1973 to 321,000 GWH in 1975. Demand started increasing again through the period 1975-1979. Peak demand has increased in all but two years during the period 1965-1979. In 1974, it declined primarily because of the oil embargo and in 1978, it declined due to a relatively mild winter heating season compared to 1976 and 1977. It should be noted that over the 14 year period of analysis, 1965-1979, both total energy demand and peak demand doubled in ECAR. Rates of increase have been lower since the 1973 embargo year.

Figure 3.1 presents data on 1979 annual and peak demands for ECAR and its sub-regions.

Figure 3.1 clearly indicates the variation in demand among sub-regions within ECAR. Depending on climate, the sub-regions alternate between summer and winter peak demands and in the same year, the season of peak demand will vary from sub-region to sub-region.

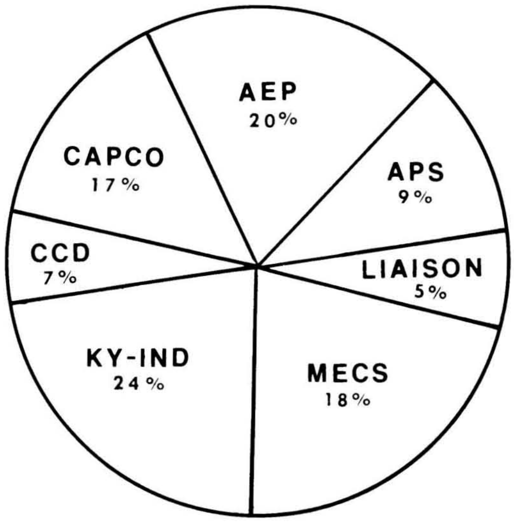
Table 3.2 presents monthly energy demand data for ECAR and its sub-regions in 1979.

The AEP, APS, and liaison sub-regions experienced winter peaks while the CCD, KY-IN, and MECS sub-regions had summer peaks. The CAPCP group had nearly equal summer and winter peaks. The ECAR region, as a whole, had its highest 1979 peak hour demand in January. The month of lowest peak hour demand for all of ECAR was October while in the AES, APS, liaison sub-regions the month of lowest peak demand was May and in the CAPCO, CCD, KY-IN, and MECS sub-regions it was October. The month of greatest total energy demand for ECAR in 1979 was January. All of the ECAR sub-regions also experienced greatest total demand in January. This is in contrast with the variation encountered in months of peak demand.

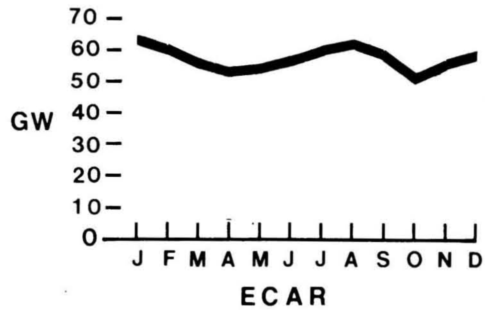
3.2 PROJECTED DEMAND

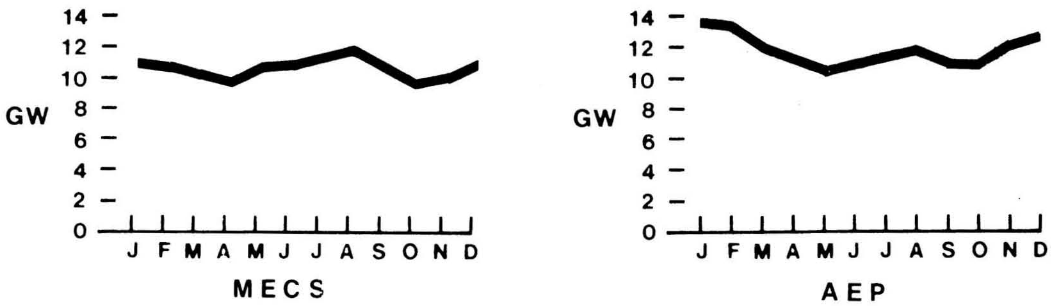
To define a reasonable range of future electricity demands which reflect different assumptions such as population and economic growth rates, impact of various conservation programs, load management, and energy pricing policies, three electricity demand projections (Projections I, II and III) were developed from published and readily available information and data on electricity demand forecasts.

Projection I is derived from the utilities. It was chosen to reflect the plans of the electric industry. Each region is required annually to forecast electric demand and supply for the subsequent ten years, and provide "conceptual planning" projections for the subsequent eleven to twenty years. The reports filed by the utilities with the Department of Energy on April 1, 1979, were the latest available for this study.



ECAR 1979 ANNUAL ENERGY DEMAND = 379,000 GWH





MONTHLY PEAK DEMAND

Figure 3.1

ECAR

1979 ANNUAL ENERGY, PEAK DEMAND, MONTHLY PEAK DEMAND

Table 3-2
1979 ECAR AND SUB-REGIONS, MONTHLY ENERGY DEMAND (THOUSANDS)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
APS												
Peak hour demand-MW	5.3	5.3	4.9	4.7	4.3	4.4	4.6	4.7	4.5	4.5	4.9	5.2
Net energy-GWH	3.2	2.9	2.8	2.6	2.6	2.5	2.6	2.7	2.5	2.7	2.7	2.9
AEP												
Peak hour demand-MW	13.1	13.1	11.7	11.1	10.1	10.4	11.1	11.5	10.7	10.7	11.9	12.3
Net energy-GWH	7.8	7.0	6.7	6.0	6.0	5.9	6.0	6.3	5.7	6.2	6.3	6.8
CAPCO												
Peak hour demand-MW	10.6	10.3	9.7	9.6	10.2	10.0	10.6	10.5	10.3	9.2	9.7	10.2
Net energy-GWH	6.2	5.6	5.7	5.2	5.4	5.4	5.6	5.7	5.1	5.4	5.2	5.5
CCD												
Peak hour demand-MW	6.4	6.3	5.4	5.4	5.5	6.1	6.4	6.8	6.2	5.0	5.6	5.9
Net energy-GWH	2.6	2.4	2.2	1.9	2.0	2.1	2.2	2.3	2.0	2.0	2.1	2.2
KY-IND												
Peak hour demand-MW	13.9	13.7	12.3	11.9	12.2	13.0	13.4	14.2	13.2	10.6	11.3	11.8
Net energy-GWH	9.0	8.3	7.9	7.2	7.3	7.6	7.9	8.0	7.1	6.7	6.7	7.3
MECS												
Peak hour demand-MW	10.7	10.4	10.1	9.7	10.6	10.8	11.2	11.3	10.6	9.5	9.9	10.4
Net energy-GWH	6.2	5.6	5.9	5.3	5.6	5.7	5.8	5.8	5.3	5.6	5.4	5.4
LIAISON												
Peak Hour demand-MW	3.3	3.2	2.7	2.7	2.5	2.8	2.9	3.0	2.8	2.8	3.1	3.1
Net energy-GWH	1.8	1.7	1.6	1.5	1.5	1.5	1.6	1.6	1.5	1.6	1.6	1.7
ECAR												
(1)Peak Hour demand-MW	63.3	62.3	56.8	55.1	55.4	57.5	60.2	62.0	58.3	52.3	56.4	58.9
Net energy-GWH	36.8	33.5	32.8	29.7	30.4	30.7	31.7	32.4	29.2	30.2	30.0	31.8

Projection II is derived from forecasts made by the Institute for Energy Analysis (IEA) at the Oak Ridge Associated Universities in September 1976. The IEA study is a well recognized independent study of the Nation's future energy demand. The IEA forecast reflects a low growth rate for both the Nation's future energy demands and the Gross National Product (GNP). It was chosen to represent the expected lower range of the electric energy forecasts. The forecast assumes a large, nationwide move to energy conservation. From this forecast, the annual per capita electric energy consumption growth rate in the United States is projected to be 2.6 percent for the period 1978-2000.

Projection III is based on the "Consensus Forecast of U.S. Electricity Demand." The electricity demand in the "Consensus Forecast" was derived from the energy demand which represents an average of 15 forecasts made by private and Federal economists in the post oil embargo period. They are conservation oriented, and not the historical growth forecasts that usually were made in the pre embargo period. Based on this study, the annual per capita electric energy consumption growth rate is expected to decrease from 4.5 percent between 1978 and 1985, to 3.2 percent between 1995 and 2000.

Table 3.3 and Figures 3.2 and 3.3 provide projections of total energy demand and peak demand for ECAR through the year 2000. Sub-region data is provided in Tables 3.4 through 3.9.

For the purposes of determining the need for additional hydropower in ECAR, Projection II, the most conservative of the three analyzed, will be used. Projection II reflects trends recently verified by utilities, such as the AEP system, which have revised their own projections of demand growth downward. AEP, in early 1980, revised its projected growth rate for the period through 1990, to an annual rate of 3.6 percent versus the previous 4.7 percent.

Projection II assumes an annual growth rate of 2.6 percent for per capita consumption in ECAR and all sub-regions. In 1978, the per capita rate for ECAR was 10.7 megawatt hours and this is projected to increase to 14.5 megawatt hours by 1990, and 18.8 megawatt hours by 2000. There is wide variation among sub-regions in per capita rates. In 1978, the APS sub-region had a rate of 13.4 megawatt hours. This gap is expected to remain the same through the year 2000, with the rate in AEP projected to be double the rate in APS.

Total energy demand for ECAR and its sub-regions is derived by multiplying projected population figures by projected per capita consumption rates. The KY-IN sub-region, which has the largest share of ECAR total energy demand (22 percent) with only 18 percent of ECAR's population will continue to account for the largest share in the year 2000 (23 percent).

Total energy demand for ECAR, using the conservative Projection II is expected to double by the year 2000. This is attributed to the per capita rate increasing from 10.7 megawatt hours to 18.8 megawatt hours and a 15 percent increase in population.

Table 3-3
ELECTRIC POWER DEMAND
EAST CENTRAL AREA RELIABILITY COORDINATION AGREEMENT (ECAR)
(1978-2000)

	1978	7 Year Growth Rate 1/	1985	5 Year Growth Rate 1/	1990	5 Year Growth Rate 1/	1995	5 Year Growth Rate 1/	2000	22 Year Overall Growth Rate 1/
Population (Thousands) 2/	34624.	.6	36118.	.8	37541.	.6	38610.	.6	39716.	.6
Projection I										
Per Capita Consump. (MWH)	10.7	3.9	13.9	3.8	16.8	3.9	20.3	2.9	23.4	3.6
Total Demand (Thous. GWH)	369.1	4.5	503.1	4.6	629.8	4.5	783.8	3.5	930.4	4.3
Peak Demand (GW)	63.3	4.9	88.2	4.6	110.6	4.5	137.9	3.5	163.4	4.4
Projection II										
Per Capita Consump. (MWH)	10.7	2.6	12.8	2.6	14.5	2.6	16.5	2.6	18.8	2.6
Total Demand (Thous. GWH)	369.1	3.2	460.8	3.4	544.6	3.2	636.8	3.2	744.7	3.2
Peak Demand (GW)	63.3	3.5	80.8	3.4	95.6	3.2	111.8	3.2	130.8	3.4
Projection III										
Per Capita Consump. (MWH)	10.7	4.5	14.5	4.0	17.7	3.3	20.8	3.2	24.3	3.8
Total Demand (Thous. GWH)	369.1	5.1	524.0	4.8	662.6	3.9	801.6	3.8	965.2	4.5
Peak Demand (GW)	63.3	5.5	91.9	4.8	116.4	3.9	140.8	3.8	169.5	4.6
Load Factor (Percent)	66.6		65.1		65.0		65.0		65.0	

Note 1/: The growth rates are average annual compounded rates over the period.

Note 2/: OBERS series E population forecasts have been adjusted to reflect the 1978 estimates of state populations as published by the Department of Commerce.

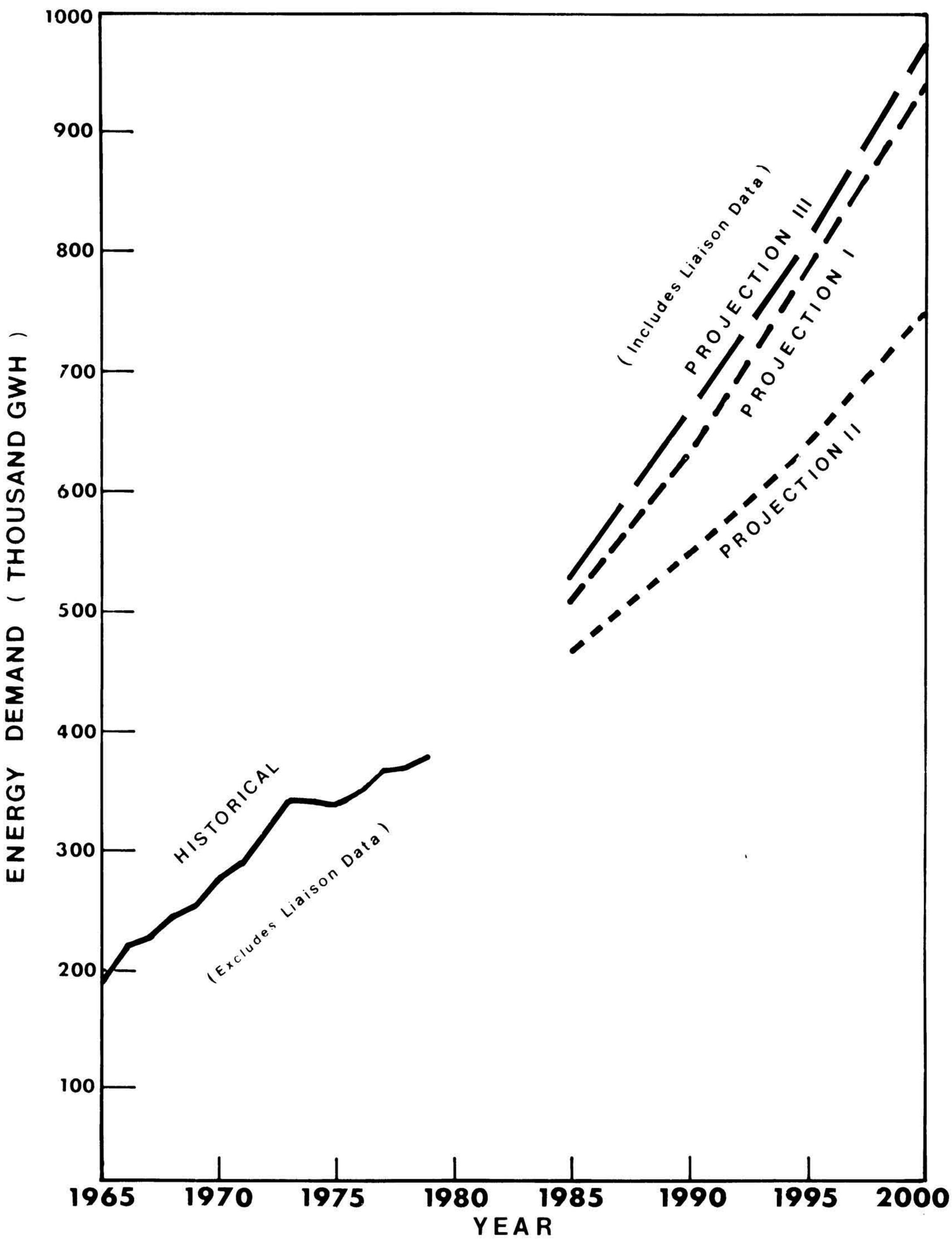


Figure 3.2

ECAR

HISTORICAL AND PROJECTED ANNUAL ENERGY DEMAND

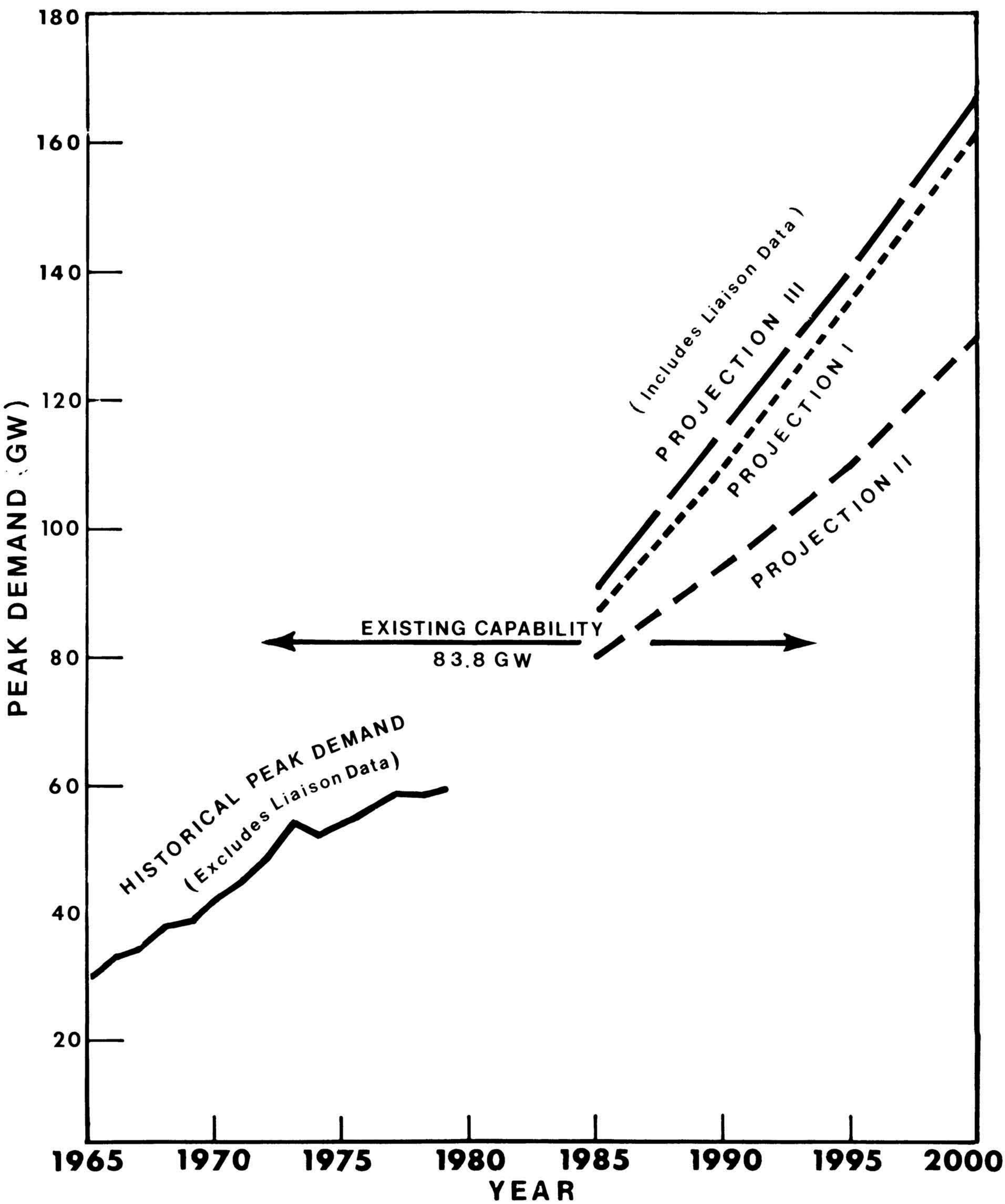


Figure 3-3

ECAR

HISTORICAL AND PROJECTED PEAK ENERGY DEMAND

Table 3-4
ELECTRIC POWER DEMAND
ALLEGHENY POWER SYSTEM
(1978-2000)

	1978	7 Year Growth Rate 1/	1985	5 Year Growth Rate 1/	1990	5 Year Growth Rate 1/		5 Year Growth Rate 1/		22 Year Overall Growth Rate 1/
Population (Thousands) 2/	4785.	.5	4927.	.2	4977.	.1	5002.	.1	5027.	.3
Projection I										
Per Capita Consump. (MWH)	6.5	4.7	9.0	4.8	11.3	4.9	14.4	4.8	18.2	4.8
Total Demand (Thous. GWH)	30.9	5.2	44.1	5.0	56.3	5.0	71.9	4.9	91.4	5.1
Peak Demand (GW)	5.2	6.2	7.9	5.0	10.1	5.0	12.9	4.9	16.4	5.4
Projection II										
Per Capita Consump. (MWH)	6.5	2.6	7.8	2.6	8.8	2.6	10.0	2.6	11.4	2.6
Total Demand (Thous. GWH)	30.9	3.1	38.3	2.8	44.0	2.7	50.3	2.7	57.4	2.9
Peak Demand (GW)	5.2	4.0	6.9	2.8	7.9	2.7	9.0	2.7	10.3	3.2
Projection III										
Per Capita Consump. (MWH)	6.5	4.5	8.8	4.0	10.8	3.3	12.6	3.2	14.8	3.8
Total Demand (Thous. GWH)	30.9	5.0	43.5	4.2	53.5	3.4	63.3	3.3	74.4	4.1
Peak Demand (GW)	5.2	6.0	7.8	4.3	9.8	3.4	11.4	3.3	13.4	4.4
Load Factor (Percent)	67.8		63.7		63.6		63.6		63.6	

Note1/: The growth rates are average annual compounded rates over the period.

Note2/: OBERS series E population forecasts have been adjusted to reflect the 1978 estimates of state popluations as published by the Department of Commerce.

Table 3-5
ELECTRIC POWER DEMAND
AMERICAN ELECTRIC POWER SYSTEM
(1978-2000)

	1978	7 Year Growth Rate 1/	1985	5 Year Growth Rate 1/	1990	5 Year Growth Rate 1/	1995	5 Year Growth Rate 1/	2000	22 Year Overall Growth Rate1/
Population (Thousands) 2/	5518.	.5	5714.	.8	5946.	.5	6096.	.6	6250.	.6
Projection I										
Per Capita Consump. (MWH)	13.4	4.2	17.9	3.4	21.2	3.5	25.1	3.5	29.9	3.7
Total Demand (Thous. GWH)	73.9	4.8	102.4	4.2	126.0	4.0	153.3	4.0	186.8	4.3
Peak Demand (GW)	13.1	4.7	18.1	4.2	22.2	4.0	27.0	4.0	32.9	4.3
Projection II										
Per Capita Consump. (MWH)	13.4	2.6	16.0	2.6	18.2	2.6	20.7	2.6	23.6	2.6
Total Demand (Thous. GWH)	73.9	3.1	91.6	3.4	108.4	3.1	126.3	3.1	147.2	3.2
Peak Demand (GW)	13.1	3.1	16.2	3.4	19.1	3.1	22.3	3.1	25.9	3.2
Projection III										
Per Capita Consump. (MWH)	13.4	4.5	18.2	4.0	22.2	3.3	26.1	3.2	30.5	3.8
Total Demand (Thous. GWH)	73.9	5.0	104.1	4.8	131.8	3.8	159.0	3.7	190.8	4.4
Peak Demand (GW)	13.1	5.0	18.4	4.8	23.2	3.8	28.0	3.7	33.6	4.4
Load Factor (Percent)	64.4		64.6		64.8		64.8		64.8	

Note1/: The growth rates are average annual compounded rates over the period.

Note2/: OBERS series E population forecasts have been adjusted to reflect the 1978 estimates of state populations as published by the Department of Commerce.

Table 3-6
ELECTRIC POWER DEMAND
CENTRAL AREA POWER COORDINATION GROUP
(1978-2000)

	1978	7-Year Growth Rate 1/	1985	5-Year Growth Rate 1/	1990	5-Year Growth Rate 1/	1995	5-Year Growth Rate 1/	2000	22-Year Overall Growth Rate 1/
Population (Thousands) 2/	6156.	.4	6330.	.6	6523.	.5	6687.	.5	6856.	.5
Projection I										
Per Capita Consump. (MWH)	10.3	3.2	12.9	2.4	14.5	2.8	16.7	2.8	19.1	2.8
Total Demand (Thous. GWH)	63.7	3.6	81.8	3.0	94.8	3.3	111.5	3.3	131.0	3.3
Peak Demand (GW)	11.0	3.7	14.2	3.0	16.5	3.3	19.4	3.3	22.8	3.4
Projection II										
Per Capita Consump. (MWH)	10.3	2.6	12.4	2.6	14.1	2.6	16.0	2.6	18.2	2.6
Total Demand (Thous. GWH)	63.7	3.0	78.4	3.2	91.8	3.1	107.0	3.1	124.8	3.1
Peak Demand (GW)	11.0	3.1	13.6	3.3	16.0	3.1	18.6	3.1	21.7	3.1
Projection III										
Per Capita Consump. (MWH)	10.3	4.5	14.1	4.0	17.1	3.3	20.2	3.2	23.6	3.8
Total Demand (Thous. GWH)	63.7	4.9	89.1	4.6	111.8	3.8	134.8	3.7	161.7	4.3
Peak Demand (GW)	11.0	5.0	15.5	4.7	19.4	3.8	23.5	3.7	28.1	4.4
Load Factor (Percent)	66.1		65.8		65.6		65.6		65.6	

Note 1/: The growth rates are average annual compounded rates over the period.

Note 2/: OBERS series E population forecasts have been adjusted to reflect the 1978 estimates of state populations as published by the Department of Commerce.

Table 3-7
ELECTRIC POWER DEMAND
CINCINNATI COLUMBUS DAYTON GROUP
(1978-2000)

	1978	7 Year Growth Rate 1/	1985	5 Year Growth Rate 1/	1990	5 Year Growth Rate 1/	1995	5 Year Growth Rate 1/	2000	22 Year Overall Growth Rate 1/
Population (Thousands) 2/	3365.	.6	5485.	.9	3645.	.6	3755.	.6	3869.	.6
Projection I										
Per Capita Consump. (MWH)	10.3	4.3	13.9	4.6	17.4	3.9	21.1	3.5	25.1	4.1
Total Demand (Thous. GWH)	34.7	4.9	48.4	5.6	63.4	4.6	79.3	4.2	97.2	4.8
Peak Demand (GW)	6.8	4.9	9.5	5.5	12.4	4.6	15.5	4.2	19.0	4.8
Projection II										
Per Capita Consump. (MWH)	10.3	2.6	12.3	2.6	14.0	2.6	16.0	2.6	18.1	2.6
Total Demand (Thous. GWH)	34.7	3.1	43.0	3.5	51.1	3.2	59.9	3.2	70.2	3.3
Peak Demand (GW)	6.8	3.1	8.4	3.4	10.0	3.2	11.7	3.2	13.7	3.2
Projection III										
Per Capita Consump. (MWH)	10.3	4.5	14.0	4.0	17.1	3.3	20.1	3.2	23.5	3.8
Total Demand (Thous. GWH)	34.7	5.0	48.9	4.9	62.2	3.9	75.4	3.8	91.0	4.5
Peak Demand (GW)	6.8	5.0	9.6	4.9	12.2	3.9	14.7	3.8	17.8	4.5
Load Factor (Percent)	58.3		58.2		58.4		58.4		58.4	

Note1/: The growth rates are average annual compounded rates over the period.

Note2/: OBERS series E population forecasts have been adjusted to reflect the 1978 estimates of state populations as published by the Department of Commerce.

Table 3-8
ELECTRIC POWER DEMAND
KENTUCKY—INDIANA GROUP
(1978-2000)

	1978	7 Year Growth Rate 1/	1985	5 Year Growth Rate 1/	1990	5 Year Growth Rate 1/	1995	5 Year Growth Rate 1/	2000	22 Year Overall Growth Rate 1/
Population (Thousands) 2/	6352.	.9	6763.	1.1	7143.	.8	7433.	.8	7735.	.9
Projection I										
Per Capita Consump. (MWH)	12.6	4.5	17.1	4.6	21.4	4.9	27.2	4.3	33.7	4.6
Total Demand (Thous. GWH)	79.9	5.4	115.7	5.7	153.0	5.8	202.4	5.2	260.6	5.5
Peak Demand (GW)	14.7	6.1	22.3	5.9	29.7	5.8	39.3	5.2	50.6	5.8
Projection II										
Per Capita Consump. (MWH)	12.6	2.6	15.1	2.6	17.1	2.6	19.5	2.6	22.1	2.6
Total Demand (Thous. GWH)	79.9	3.5	101.8	3.7	122.3	3.4	144.6	3.4	171.1	3.5
Peak Demand (GW)	14.7	4.2	19.6	3.9	23.7	3.4	28.1	3.4	33.2	3.8
Projection III										
Per Capita Consump. (MWH)	12.6	4.5	17.1	4.0	20.8	3.3	24.5	3.2	28.7	3.8
Total Demand (Thous. GWH)	79.9	5.4	115.8	5.1	148.8	4.1	182.1	4.0	221.8	4.8
Peak Demand (GW)	14.7	6.1	22.3	5.3	28.9	4.1	35.4	4.0	43.1	5.0
Load Factor (Percent)	62.0		59.2		58.8		58.8		58.8	

Note1/: The growth rates are average annual compounded rates over the period.

Note2/: OBERS series E population forecasts have been adjusted to reflect the 1978 estimates of state populations as published by the Department of Commerce.

Table 3-9
ELECTRIC POWER DEMAND
Michigan Electric Coordinated System
(1978-2000)

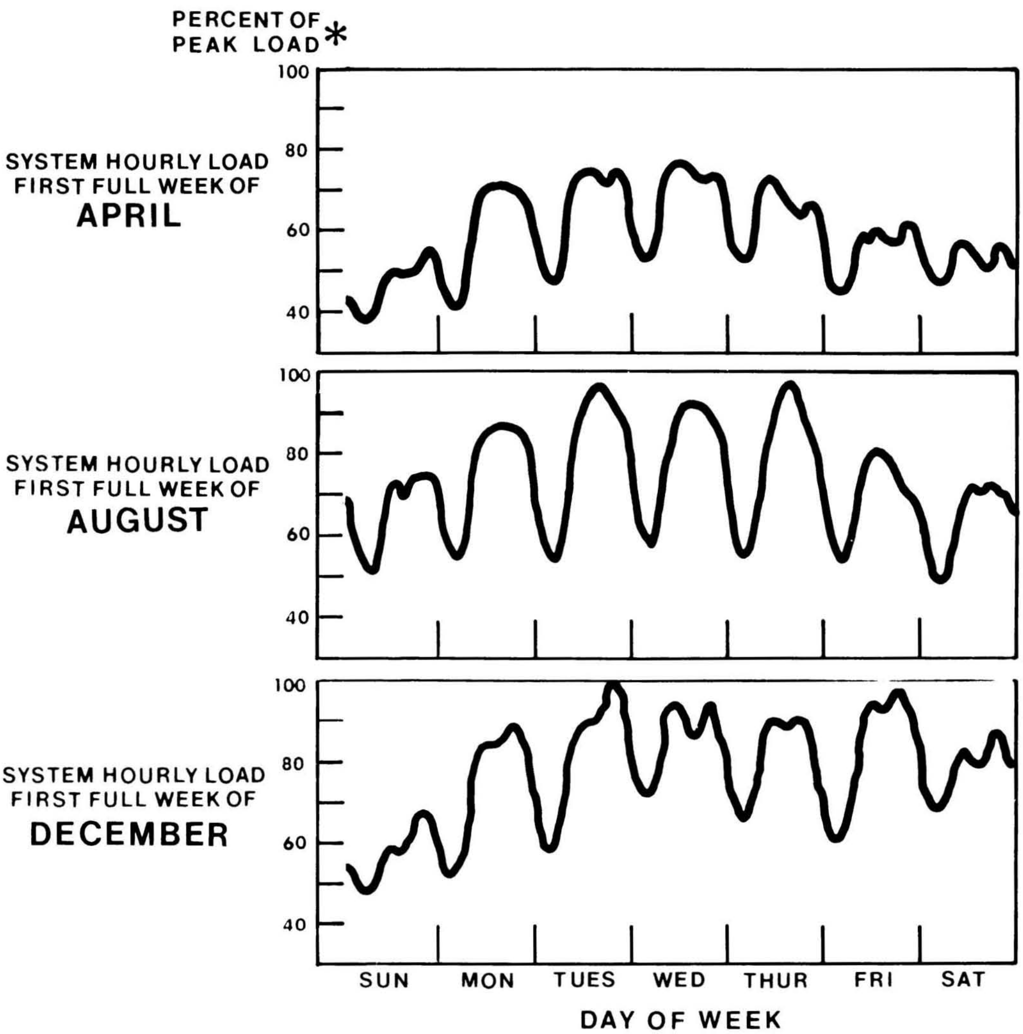
	1978	7 Year Growth Rate 1/	1985	5 Year Growth Rate 1/	1990	5 Year Growth Rate 1/	1995	5 Year Growth Rate 1/	2000	22 Year Overall Growth Rate 1/
Population (Thousands) 2/	8475.	.7	8899.	.9	9307.	.7	9637.	.7	9979.	.7
Projection I										
Per Capita Consump. (MWH)	8.0	2.3	9.3	2.3	10.5	2.1	11.6	2.0	12.9	2.2
Total Demand (Thous. GWH)	67.4	3.0	83.0	3.3	97.4	2.8	112.1	2.8	128.4	3.0
Peak Demand (GW)	11.9	3.1	14.7	3.3	17.3	2.8	19.9	2.8	22.8	3.0
Projection II										
Per Capita Consump. (MWH)	8.0	2.6	9.3	2.6	10.8	2.6	12.3	2.6	14.0	2.6
Total Demand (Thous. GWH)	67.4	3.3	84.7	3.5	100.7	3.3	118.6	3.3	139.6	3.4
Peak Demand (GW)	11.9	3.4	15.0	3.6	17.9	3.3	21.0	3.3	24.8	3.4
Projection III										
Per Capita Consump. (MWH)	8.0	4.3	10.8	4.0	13.2	3.3	15.5	3.2	18.1	3.8
Total Demand (Thous. GWH)	67.4	5.2	96.3	4.9	122.5	4.0	149.3	3.9	180.9	4.6
Peak Demand (GW)	11.9	5.3	17.1	5.0	21.8	4.0	26.5	3.9	32.1	4.6
Load Factor (Percent)	64.7		64.5		64.3		64.3		64.3	

Note1/: The growth rates are average annual compounded rates over the period.

Note2/: OBERS series E population forecasts have been adjusted to reflect the 1978 estimates of state populations as published by the Department of Commerce.

Figure 3.4 shows a typical weekly demand curve for ECAR. The projections analyzed assume only slight variation in load factors over the period of analysis. The load factor is the figure which characterizes the variations in peaks and valleys in the demand figures. The energy demand figures shown on tables 3.3 through 3.9 do not occur uniformly. The demand varies on a fairly predictable basis with peaks or periods of high demand preceded and followed by valleys or periods of lower demand. Annual peaks are caused by winter heating and summer air conditioning demands. On a weekly and daily basis, peaks vary by time of day and day of week due to work place and residential demands for electric power. Load factor is the base demand for a system divided by peak demand and is expressed as a percentage. A lower load factor characterizes wide variations between peaks and valleys. As load factor increases these variations flatten out. A load factor of 100.0 percent would indicate no peaks or valleys in demand. Load factors in ECAR varied in 1978, from 58.3 percent in the CCD sub-region to 67.8 percent in the APS sub-region. Load factor is expected to change only slightly over the period of analysis for ECAR, remaining at about 65 percent.

Using the projected load factor and the projected total demand figure, a projected peak demand figure is derived. Peak demand is projected to double by 2000 for ECAR as a whole, while peak demand in the MECS and KY-IN sub-regions will more than double.



* Peak load is equal to the largest system load in the first full week of April, August and December.

SOURCE: Data obtained from FERC Form No. 12 (Schedules 14 and 15) for 1977.

Figure 3.4

TYPICAL DEMAND CURVE

Chapter 4
EXISTING AND FUTURE ENERGY SYSTEM

4.1 DESCRIPTION OF EXISTING SYSTEM

Table 4.1 presents the existing energy system mix for ECAR and its sub-regions, and Figure 4.1 indicates the percentage of energy capacity by type of power source in 1978 for both ECAR and the Nation.

Eighty percent of the generating facilities within ECAR utilize coal to drive steam turbines. Nuclear- and oil-fired steam plants provided about 4 and 7 percent of generating capability in 1978. Combustion turbine plants, pumped storage, conventional hydroelectric facilities, and other types of plants made up the remainder of generating capability. This generation mix is in sharp contrast with national trends where coal plays a less dominant role.

Nuclear power plants are operated by the American Electric Power System, the Central Area Power Coordination Group and the Michigan Electric Coordinated System. The American Electric Power System and the Kentucky-Indiana Group have nearly half of ECAR's coal derived electric power capability. The MECS sub-region accounts for the largest usage of oil in ECAR with the CCD sub-region also having significant oil usage. Data on actual usage of oil within ECAR is available for 1977. As reported by the utilities in the <u>8th Annual Review of Overall Reliability and Adequacy of the North American Bulk Power Systems</u>, published by the National Electric Reliability Council in August 1978, oil usage for electric power generation was as below.

Distillate oil, steam generation	2,964,000 barrels
Distillate oil, combustion turbine	7,611,000 barrels
Distillate oil, combined cycle	1,590,000 barrels
Residual oil, steam generation	16,051,000 barrels
Crude oil, steam generation	1,630,000 barrels
	29,846,000 barrels

Hydropower, including conventional hydroelectric and pumped storage, is about 4.1 percent of the ECAR system generating capability as compared to about 12 percent for the Nation as a whole. The majority of hydropower facilities are pumped storage plants. Conventional hydropower plants represent 1.1 percent of the ECAR system generating capability. Most of the plants serve as intermediate or peaking generating facilities, except in high flow months when some operate as base. Conventional hydro operated for peaking in various degrees includes Markland Dam on the Ohio River, the Claytor and Leesville facilities in Virginia, and several small AEP plants.

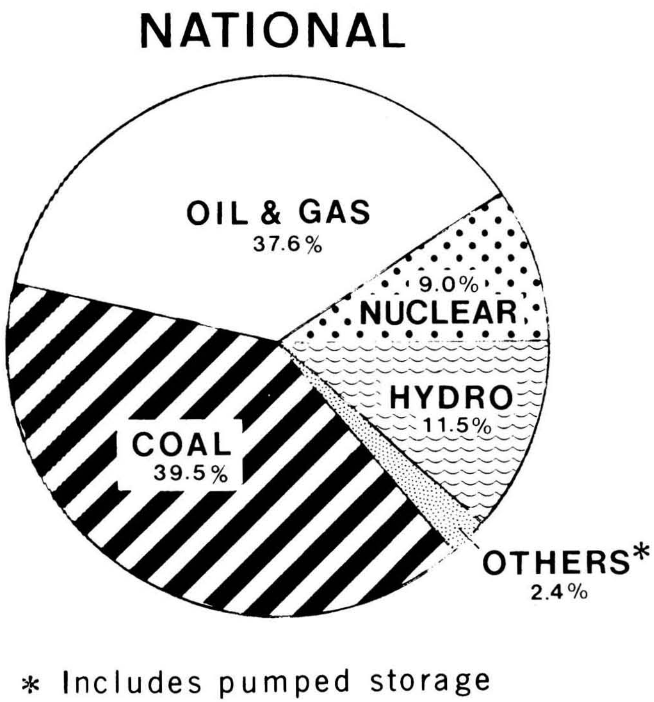
In addition to their intermediate or peaking role, hydroelectric plants with adequate storage for daily or longer periods provide a rapid response type generation to the systems in which they operate.

Table 4-1
ECAR EXISTING GENERATING CAPABILITY BY TYPES OF PLANTS
(AS OF JANUARY 1, 1978)

			STEAM TURBINE			Combined		Pumped	COMBUSTION TURBINE		INTERMAL COMBUSTION			
		NUCLEAR	Gas	Coal	Oil	Cycle	Hydro	Storage	Gas	Oil	Gas	Oil	OTHERS	TOTAL
Allegheny Power System	MW	-	-	5871	486	-	62	-	-	-	-	1.0	-	6429
	%	-	-	91.3	7.6	-	1.0	-	-	-	-	0.1	-	100.0
American Electric Power System	MW	1050	-	14570	240	-	543	140	-	18	-	-	-	16561
	%	6.3	-	88.0	1.4	-	3.4	0.8	-	0.1	-	-	-	100.0
Central Area Power Coordination Group	MW	1222	-	11528	770	568	-	365	-	410	-	31	-	14894
	%	8.2	-	77.4	5.2	3.8	-	2.4	-	2.8	-	0.2	-	100.0
Cincinnati Columbus Dayton Group	MW	-	-	6980	278	-	-	-	72	910	-	106	110 1/	8456
	%	-	-	82.5	3.3	-	-	-	0.9	10.8	-	1.2	1.3	100.0
Kentucky-Indiana	MW	-	71	16264	491	-	124	-	127	507	-	33	-	17617
	%	-	0.4	92.3	2.8	-	0.7		0.7	2.9	-	0.2	-	100.0
Michigan Electric Coordinated System	MW	791	21	8460	3250	-	134	1872	626	408	-	152	-	15714
	%	5.0	0.1	53.8	20.7	-	0.9	11.9	4.0	2.6	-	1.0	-	100.0
Liaison Members	MW	-	8	3719	107	25	35	-	-	199	54	68	-	4215
	%	-	0.2	88.3	2.5	0.6	0.8	-	-	4.7	1.3	1.6	-	100.0
ECAR Total	MW	3063	100	67392	5622	593	898	2377	825	2452	54	390	120	83886
	%	3.7	0.1	80.3	6.7	0.7	1.1	2.8	1.0	2.9	0.1	0.5	0.1	100.0

Source: Based on winter generating capability reported to the Department of Energy, FERC (FPC) Order 383-4, Docket R-362, April 1978.

1/ Jet Engine - Kerosene



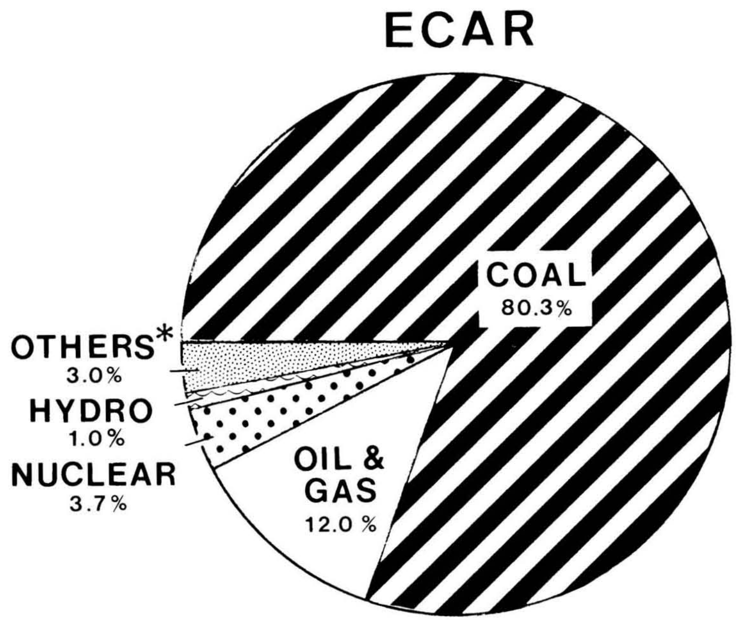


Figure 4.1

NATIONAL AND ECAR ELECTRIC GENERATION CAPACITY BY SOURCE (1978)

Table 4.2 provides a listing of hydropower plants presently operating within ECAR.

Table 4-2
ECAR HYDROPOWER CAPABILITY (1978)

Owner	Plant Name	Capability (MW)
Allegheny Power System	Lake Lynn	52
	Misc.	10
American Electric Power System	Smith Mountain	320
	Claytor	76
	Leesville	40
	Misc. Small Hydro	107
Kentucky-Indiana Group	Markland	55
	Dix Dam	24
	Ohio Falls	35
	Norway	4
	Oakdale	6
Michigan Electric Coordinated System	Misc. Hydro	134
ECAR Liason Members	Misc. Hydro	38
Total		898

These plants are reported to the U.S. Department of Energy by ECAR. All of the plants are investor owned. In addition, ownership of small, unreported plants are approximately as follow: Industrial 110 megawatts, Public (non-Federal) 9 megawatts, Federal 18 megawatts, Investor owned 68 megawatts and cooperative owned 1 megawatt. Total 206 megawatts.

As reported by the utilities, there are three new hydropower plants under construction: Racine (40 megawatts), Greenup (70 megawatts) and Cannelton (70 megawatts) on the Ohio River. Another hydro project on the Ohio River at Gallipolis Lock and Dam is in advanced planning stages. Recently there have been numerous filings of preliminary permit applications with the Federal Energy Regulatory Commission for the study of hydropower development at other Ohio River locks and dams.

4.2 SYSTEM RELIABILITY AND RESERVE MARGIN

Reserve margin is the amount by which operable power production capability of a system exceeds peak demand on the system. Reserve margin is usually expressed as a percentage of the peak demand. With an existing system capacity of 84,000 megawatts and a peak demand of about 63,000 megawatts, ECAR's reserve margin in 1978 was 33 percent.

When planning system expansion, an electric utility system evaluates several factors which have a significant impact on system reliability. Among these factors are the size and expected availability of existing and planned generating units, unit reliability, possible delays of in-service date of new units, interconnection with other utility systems, probable availability of supplemental capacity resources, and system load characteristics.

A significant factor influencing power supply adequacy in ECAR is the random outage of generating capacity due to unforeseen partial outages and unplanned unit outages. Coal-fired generating capacity, the predominant type in ECAR, generally experiences a higher level of unavailability as compared to oil-fired or gas-fired capacity due to the abrasive nature of coal and the extreme stresses it imposes on equipment. Further adding to coal-fired difficulties, is the wide variation in heat, ash, and moisture content, all of which greatly impact the performance of coal-fired capacity.

An analysis of the random weekday outages of generating capacity within ECAR during a two-year period (1976-1978) indicates that the minimum amount of unavailable capacity that can be expected each weekday is 12.7 percent of daily net season capability. The analysis also shows that there is a 10 percent probability that random unavailable capacity would exceed 26.5 percent of daily net seasonal capability, and that average random unavailable capacity is about 21 percent.

Based on the above system reliability factors, ECAR utilities generally maintain a reserve margin of about 25 percent of peak demand. For the purposes of discussing future new capacity requirements, 25 percent reserve margins will be assumed adequate.

4.3 OPERATING PROCEDURES WITHIN ECAR

(The following is excerpted from Volume I of *ECAR Regional Reliability Council Coordinated Bulk Power Supply Program, ERA-411, 1 April 1980.)*

The major portion of the existing and planned generating capability in ECAR is either coal-fired or nuclear. As long as an adequate supply of fuel is available for those two types of generation, energy requirements (kilowatthours) will not substantially influence planning or day-to-day operation. Peak load demand has been, and continues to be, the governing factor in either case.

Experience indicates that seasonal peak demands are most likely to occur during a period of extreme weather conditions and there is a reasonable probability that such weather conditions will prevail throughout the entire region at a given time. Under such circumstances, there will be little or no load diversity in ECAR during that particular season. Due to differences in the composition of load on various systems, however, the magnitude of the seasonal peak demand for each system is apt to be higher in one particular month of the season than in another and this month would not be the same for all systems.

Coordinated parallel operation of the generating units and the bulk power transmission networks of the 26 power systems within the ECAR region is directed by 17 Power Control Centers. Northern Indiana Public Service Company is included within the control area of Commonwealth Edison Company of Chicago. However, essential functions such as breaker control and system monitoring are performed at its Hammond, Indiana, center.

These control centers are staffed 24 hours a day with personnel trained in system operation, and are equipped with essential control and communication facilities to carry out the two primary functions of maintaining; (1) balance between system load and generating resources; and (2) maximum system security.

The control equipment at the Power Control Centers and at the individual generating units is designed for voltage dips or momentary disruptions such as transfer to emergency power sources. The control equipment includes redundant "fail safe" features to assure that there will be no uncontrolled power swings caused by control equipment malfunction.

Extensive intercompany and area communication facilities are used by ECAR and its members to coordinate normal and emergency system operations among and between the power control centers of ECAR and adjoining regions.

Information is transmitted daily by teletype to the ECAR Executive Manager's office in Canton, Ohio, by each system giving the system's projected load for the coming day's peak, scheduled purchases, scheduled sales and status of system generation. From this information, the staff compiles a composite projection of system conditions for the following day. This projection is then transmitted to all of the ECAR systems for their information and use in scheduling generation and interchanges for the proper amount of operating reserves.

A leased-line private telephone system, independent of intercompany communication facilities is also provided which allows five area coordinators and the ECAR office to be in contact on an individual or collective basis during a fast-developing emergency situation. The five area coordinators provide an overview of regional conditions, and are responsible for staying abreast of day-to-day system conditions that affect the reliability and adequacy of power supply within their respective area of the ECAR region. The coordinators and their alternates are managerial personnel of the system, operating departments of their respective companies, and have the authority to make immediate decisions on matters affecting the operation of the bulk power system. Through use of the communication channels *described above, the five area coordinators can directly and immediately communicate with the other operating companies in their area of responsibility, as well as with the systems adjacent to ECAR which interface their area.*

4.4 PROJECTED SUPPLY

An analysis of Projection II clearly illustrates that a need for new electric power capacity in ECAR and each of its sub-regions will exist through the foreseeable future. In 1978, ECAR's total electric power capacity was about 84,000 megawatts and peak demand was 63,000 megawatts leaving a reserve margin of 33 percent. Projection II for ECAR indicates a peak demand by 1990 of 96,000 megawatts. In order to maintain a reserve margin of about 25 percent, a total capacity of 120,000 megawatts would be required or about 40,000 megawatts of new capacity. To meet new capacity requirements, ECAR utilities project that about 25 percent of new capacity will be nuclear, about 67 percent coal-fired, and about 8 percent other sources including oil- and gas-fired combustion turbines and combined cycle plants as well as pumped storage. Although the role of nuclear is forecasted to increase substantially, coal will continue to be the dominant fuel.

4.5 POTENTIAL ROLE OF HYDROPOWER

While hydroelectric is not now, and cannot in the foreseeable future, be a dominant source for ECAR's electric power needs, it can play a complementary role in the region and may play a significant role locally. Hydro's complementary regional role derives from its operational characteristics.

Hydroelectric can improve system reliability because near term availability of water is predictable and hydro turbines experience low maintenance and repair requirements compared to outage rates of coal-fired and nuclear-fired plants.

Hydroelectric can increase system flexibility. Mechanical adjustments to change the energy output from hydro turbines can be accomplished in seconds. Even with operational constraints to avoid adverse environmental impacts, hydro can add significant flexibility to ECAR's coal-fired electrical systems.

Hydroelectric can reduce the use of oil by operating to meet peak electric demands. Consistent with other project purposes and environmental design criteria, many hydro projects in ECAR could be operated to follow daily variations in demand. This load following capability could be utilized to displace some of the 30 million barrels of oil consumed annually by ECAR utilities.

Hydroelectric at storage projects can provide an emergency reserve. A small amount of water flow can keep a hydro turbine spinning so that it may be brought on line very quickly in the case of a system emergency. In the event of a system failure, hydro can provide the energy necessary to start up ECAR's large thermal generators.

On a regional basis, reliable hydroelectric capacity could forestall the need for additional gas- or oil-fired capacity and could replace these types of units as they are retired.

Hydro in ECAR can also play a significant role on a local basis in ECAR, providing the smaller systems with significant amounts of energy. Hydro's importance is related to the size of the facility compared to the system it serves. While a 15 megawatt plant may not be regionally significant, it may be very important to a smaller system where peak demand is in the range of 50 megawatts. Since the hydro resource in ECAR is distributed throughout the region, its future role lies with the scattered small utilities in the region rather than with the large bulk power systems.

4.6 PARAMETERS GOVERNING USE OF HYDROPOWER

There are several parameters which affect the use and operation of existing hydro facilities. These parameters depend to a large extent on ownership and location of the facilities. Some of the more prominent parameters are discussed below.

Institutional

Hydropower use in the ECAR region is regulated by Federal law and policy. Federally constructed plants operate under established criteria in accordance with the overall project plan authorized by Congress. The "preference clause" governing the sale of Federally-produced power has considerable impact on the use of hydropower. By law, Federal power must be offered for sale to municipalities, cooperatives, and other publicly-owned utilities before investor-owned utilities.

The remaining hydroplants in the ECAR region are operated in accordance with their Federal Energy Regulatory Commission (FERC) licenses. Once established, the operating procedures may only be changed through petition to FERC. The operating procedures are established or later changed only after detailed consideration of all impacts, particularly the impacts on other hydro projects or downstream water users. Within the procedures set forth in the license, the power company is free to operate the plant as necessary to meet power demands.

In addition to the factors noted above, the state in which the project is located may require that the project operation be modified in order to meet state standards for downstream water needs. Many projects have operating procedures that reflect state standards or restrictions, particularly in the area of environmental and social impacts.

Social

The social parameters that affect the operation of hydropower facilities are often reflected in the institutional arrangements noted above for the operating procedures. Occasionally, power production at a hydropower facility is curtailed due to impacts on reservoir users or downstream water users. Recreational use of existing reservoirs is extremely heavy in the ECAR region resulting in a public demand for a fairly constant pool level with minimal fluctuation or drawdown. Therefore, even though the original project planning may have adjusted the operating procedures for hydro to enhance recreational use, additional temporary adjustments may be required at times due to limited water and heavy recreational use. Other short term constraints on pool fluctuations may be imposed by water level requirements for recreational events such as boat races and fishing tournaments.

Social considerations may also tend to increase power generation over short periods at hydro projects. During periods of unusually high electricity demand, the hydropower facilities may be operated at a higher plant factor than normal to help meet the demand.

Other social impacts relate to downstream water use. Additional releases may be desired during the normal nongenerating times in order to meet certain downstream needs, such as water quality or water supply. Temporary needs of this type can often be handled under normal project operation even though these releases may have negative impacts on power generations by changing peak releases to off-peak releases. Long term downstream needs have occasionally resulted in permanent modifications to existing project operation procedures.

In any case, hydro operational regimes must strike a balance between competing uses.

Economic

Economic parameters governing the use of hydropower are generally related to the higher value placed on peak power than off-peak power. As such, hydropower plants at storage reservoirs are generally designed as peaking units with primary emphasis placed on the installed capacity. Operation procedures are then based on a low (less than 20%) plant factor in order to operate at full capacity. This provides the maximum energy during periods of peak demand.

Another major economic factor that governs the use of existing Federal hydropower plants, is the pricing policy established for hydropower. Power produced and marketed by the Federal government is priced to repay investment costs allocated to the hydro facilities, including interest and operation and maintenance costs, thus this power is usually considerably less expensive than alternative power and the demand for this power is high.

Physical

The most significant physical parameter affecting the use of existing hydropower facilities is generally the availability of water for generation. During periods of excess water, the hydroplant must often generate during off-peak periods to avoid wasting the excess water. During dry periods, power production may have to be curtailed because of a lack of water. Downstream needs may also impact plant operation by requiring water releases when not desired for power production. These needs may be accented by varying hydrologic conditions such as either water shortage or flooding. The severity of these impacts due to water availability depends on the original planning and design of the project. Power production at storage projects is generally impacted less by short-term water shortage or excess than run-of-river projects.

4.7 MARKETING FEDERAL HYDROPOWER

Currently, no formal mechanism exists within the ECAR region to provide for the sale of electric power produced by Federally-owned hydroelectric plants. Only one Federal facility currently produces power in ECAR and the output from that plant is marketed through a direct agreement between the government and a utility. The Federal Department of Energy is responsible for marketing Federally-produced power through its marketing Administrations such as SEPA (the Southeast Power Administration and BPA (the Bonneville Power Administration)). Studies are currently underway to determine the need for such a regional marketing Administration for the northcentral United States including ECAR as a result of the likelihood of increased Federal hydropower in this region.

Chapter 5
DESCRIPTION OF METHODOLOGY FOR EVALUATION OF POTENTIAL HYDROPOWER

Regional hydroelectric power studies were accomplished in four separate stages. The first three stages involved different levels of screening to successively eliminate sites which did not meet increasingly severe evaluation criteria. The fourth stage entailed formulation of the regional plan.

5.1 STAGE 1 SCREENING

The first step in identifying potential hydropower sites was a compilation of an inventory of all dams and potential dam sites having some physical potential to generate power. Because an extensive computerized data base had been developed for existing dams for the Corps' National Program of Inspection of Dams, it was used as the foundation of the inventory. Known undeveloped sites, and extremely low head dams which may not have been included in the inspection inventory were added to this foundation. The data base followed the format and utilized the data of the existing inspection inventory to the maximum extent possible. Data on the location, ownership, available power head, and average streamflow of each existing dam and potential dam site were included in the data base. The original base included about 4500 dams and dam sites ranging from very small water supply reservoirs to the Ohio River navigation dams. It was from this point that the screening process began.

The first level of analysis assumed that a continuous inflow, developed from a generalized flow equation for the specific site drainage area, could be passed through turbines at a head equal to the hydraulic height of the dam. This initial screening criterion indicated far more hydropower potential at each dam or dam site than could actually be developed. A dam or site had to have a potential capacity of 50 kilowatts or more to pass this criterion. Screening on this initial criterion reduced the number of sites under active consideration from approximately 4500 to approximately 1200.

5.2 STAGE 2 SCREENING

The purpose of the second screening activity was to screen out those existing and undeveloped dam sites that did not meet simplified economic evaluation standards. Sites were screened according to a ratio of power benefits, measured by generalized power values, and the costs of only the powerhouse facilities (powerhouse and switchyard).

The second level of analysis involved determination of at-site flow duration curves. Site-specific flow data, along with refined estimates of available net power heads, were utilized to compute an actual physical potential for hydroelectric power at each project. The large number of sites, both developed and undeveloped, in the Stage 2 inventory made it necessary to use generalized cost curves to develop cost estimates for power facilities. Costs were developed for a range of capacity and hydraulic head levels for the powerhouse and switchyard facilities only. Benefit evaluations were based upon generalized power values furnished by the Federal Energy Regulatory Commission. These power values were derived from the cost of the most likely single thermal alternative to a hydropower project.

A benefit cost ratio (BCR) of about 0.7 for existing dams and about 0.5 for undeveloped sites was utilized for Stage 2 screening. Since only partial costs of power development were used, these BCR's were simply a device for eliminating clearly uneconomic sites from further consideration. The number of sites in the active inventory after the Stage 2 screening exceeded 600.

5.3 STAGE 3 SCREENING

Stage 3 evaluations involved the following efforts and parameters:

- Expansion of physical site data and analysis of capacity and energy potential;
- Development of more complete cost estimates and updated power values;
- Determination of project capability to respond to seasonal, weekly, and daily variations in demand for electric power;
- Identification of potentially significant environmental and social impacts.
- Estimating the probable time requirements for development of individual sites;
- Obtaining the views of owners and operators of existing dams; and
- Encouraging and evaluating comments by the general public.

Stage 3 evaluations provided a basis for an iterative screening process with the objective of identifying projects which demonstrated reasonable potential for inclusion in a regional plan and determining general operating characteristics and timeframes for development. Stage 3 also involved coordination efforts to insure compatibility of the screening procedures utilized by the several Corps of Engineers offices with responsibility for site assessment studies within ECAR. On the basis of Stage 3 efforts, about 250 sites were found to warrant consideration for inclusion in a regional plan.

5.4 STAGE 4 SCREENING

Stage 4 provided for formulation of the regional plan for hydroelectric development. Activities involved:

- Selective refinements of site evaluation studies;
- Analysis of existing and forecasted regional supply and demand;

- Establishing plan formulation objectives and criteria;
- Formulation of a tentative regional plan;
- Public information and feedback analysis including a formal public hearing; and
- Development of a recommended regional plan.

Site refinement studies were oriented toward improving the reliability of the project data base and determination of potential project operational characteristics. Also, particular attention was directed toward sites with limited potential (hydroelectric capacity in the range of 1 megawatt) but with otherwise excellent physical characteristics for hydro development. Several sites with these characteristics were determined to warrant further consideration as localized hydro potential.

Supply and demand analyses highlighted the sharp contrasts in primary sources of electric energy within ECAR and the Nation as a whole and provided a basis for outlining the potential future role of hydro within ECAR. In this regard, the optimum role of hydro within the fossil fuel-intensive ECAR system is to:

- Complement coal fired generating facilities; and
- Reduce utilization of oil fired generating facilities.

Supply and demand analysis and determination of potential project operational characteristics provided a basis for establishing explicit plan formulation objectives and criteria. These objectives and criteria provided direction and structure for an iterative plan formulation process which began with establishment of a preliminary regional plan.

The preliminary regional plan reflected technical data and public inputs resulting from Stage 4 screening efforts. A critical component of the preliminary plan formulation process was to identify site refinement study requirements on a project by project basis. These site refinement studies and feedback from an effort to contact owners of all non-Federal dams considered during Stage 4 provided a basis for formulation of a tentative regional plan.

A summary of preliminary study findings and specific information on each project included in the tentative regional plan was distributed to all known interested parties. Questions, comments, and participation in a regional public meeting were invited. Feedback from this intensive public involvement effort was the primary basis for evolving the recommended regional plan.

Chapter 6
PUBLIC INVOLVEMENT

Beginning with the early stages of the ECAR regional study, public involvement activities have been integrated with the plan formulation process to ensure that sites selected for inclusion in a regional plan reflect the views of the public.

Public involvement activities began in June 1979, with a news release throughout the ECAR area which announced the inventory of potential hydropower sites which had been developed from the Stage 2 screening process. This news release discussed the background of the study and provided data on how to obtain site specific information. About 100 inquiries were received as a result of this release.

In late December 1979, and January 1980, a fact sheet was distributed by the Ohio River Division and other study participants. This fact sheet provided background data on the NHS and the ECAR region. It discussed the background and objectives of the National study, and provided information on the study methodology and data on electric power characteristics of ECAR. Existing and projected electric power demand trends in the region were discussed as well as the characteristics of existing generation facilities in ECAR. A discussion of potential regional study objectives was also presented. This fact sheet was distributed to several thousand agencies and individuals within ECAR. Response to this fact sheet was moderate, consisting primarily of responses requesting continued inclusion in public involvement activities.

Distribution was made of a second fact sheet in May 1980, which provided information on the characteristics of existing and potential hydropower in ECAR, regional power needs, and tentative regional objectives for development of additional hydropower in ECAR. A map showing the location of existing and potential hydropower sites was provided. It also requested public comments on suitability of sites for development.

Next, a list of potential sites was considered as the basis of a preliminary regional plan. Efforts were made to contact owners of all non-Federal sites to provide them with data and to solicit their views on the data and development potential of the site. As a result of this coordination, data were revised and site owner views were incorporated into the plan formulation and screening process. Public response and coordination with potential site owners were significant factors in determining the listing of sites remaining at the end of the Stage 3 screening process.

During the Stage 4 screening process, a listing of potential ECAR hydro sites with tentative plan designations was distributed region-wide along with a formal announcement of a public meeting on the tentative regional plan. These plan brochures and meeting announcements were distributed in August 1980 and were followed by news releases on the same topic. The plan brochure summarized study findings and presented a description and listing of about 200 sites which were proposed for inclusion in the regional plan. Approximately 30 written responses to the plan brochure and several hundred telephone inquiries were received. Additionally, the news media, radio and television stations and newspapers, in the nine state region requested supplementary information on hydropower planning activities. A public meeting for the study was conducted on 4 September 1980 in Cincinnati, Ohio. Approximately 80 persons attended and presented oral or written statements, or participated in formal and informal question and answer sessions. A written transcript of the hearing is part of the study record.

During the study process, liaison, both formal and informal, has been maintained with state and Federal agencies in the ECAR region. This liaison has consisted of the normal written correspondence as well as briefings with staff members of Federal and state agencies.

The draft report prepared in early 1981, was sent to approximately fifty state and regional governmental agencies for review and comment. Thirteen responses were received and are provided as Appendix B of this report. Responses received can be categorized as follows:

- Site specific--Information was provided for several sites which provided more current data on existing energy output. This data was corrected in Exhibit 1 of the report. A letter from the Susquehanna River Basin Commission noted environmental constraints at both the Foster Joseph Sayer and G. B. Stevenson sites.

- Generalized--Many responses were of an editorial nature and suggested different wording or different emphasis be given to issues discussed in the text. These comments can be found in Exhibit 2.

As a result of public involvement activities, data on plan sites have been improved, developmental constraints identified, and views on individual site suitability obtained and incorporated in the regional plan.

Chapter 7
INVENTORY

As previously noted in Chapter 5, about 600 potential hydro sites remained in active consideration after Stage 2 screening efforts. These sites were published in a report entitled "Preliminary Inventory of Hydroelectric Power Resources" distributed in July 1979, and announced by a region-wide news release.

Table 7.1 provides a potential capacity breakdown of these sites by state.

Table 7-1
NUMBER OF SITES BY STATE AND POTENTIAL CAPACITY
ECAR, 1979 PRELIMINARY INVENTORY

Potential Capacity (MW)	IN	KY	MD	MI	OH	PA	VA	WV	Total	%
1-4	74	67	9	85	83	32	32	44	426	70
5-9	2	2	0	21	3	3	6	1	38	6
10-14	0	0	0	3	0	0	1	3	7	1
15-24	1	2	1	2	7	2	2	6	23	4
25-49	2	15	3	3	2	11	8	14	58	10
50-99	1	8	0	1	0	6	0	7	23	4
100+	2	8	0	0	0	4	1	14	29	5
Total	82	102	13	115	95	58	50	89	604	100

As illustrated by the table, about 70 percent of the sites identified have less than five megawatts potential capacity.

Thirty-one percent of the sites in the preliminary inventory are Federal, nine percent are state-owned, and 60 percent are owned by local government, private industry, and others. Nearly all of the Federally-owned sites are multipurpose reservoirs or navigation locks and dams. Most of the larger potential capacity sites (over 25 megawatts) are Federally owned multipurpose reservoirs and low-head navigation structures on larger rivers such as the Ohio.

As discussed in Chapter 5, the 604 sites were further evaluated in Stage 3 of the screening process. Additional site specific evaluations were performed based on expanded site data, refined cost estimates, further benefit evaluations, and more thorough analyses of streamflow characteristics. On the basis of the Stage 3 screening process, approximately 250 sites were retained for further evaluation for consideration of inclusion in a regional plan. Most of the 350 sites eliminated were done so on the basis of economic infeasibility or insignificant power potential.

The 4th stage of screening activities included selective refinement of site evaluation studies, analysis of existing and forecasted regional supply and demand, establishment of plan formulation objectives, analyses of environmental factors, and public information and feedback analysis including the formal public hearing. These activities eliminated approximately 60 sites from further consideration. About 45 sites were eliminated because they were found to lack significant potential capacity based on further analyses of streamflow data. The other sites were eliminated because further analyses determined economic infeasibility or significant environmental drawbacks such as scenic river designations. Additionally, several sites were eliminated because final coordination with site owners revealed significant conflicts with existing project purposes.

The 194 sites remaining for consideration in the regional plan are predominantly Federally owned and consist mostly of existing multipurpose reservoir dams and navigation locks and dams. Most of the remaining non-Federal sites are existing dams used for a single purpose such as flood control, water supply, and recreation. Many of the sites, predominantly those in Michigan, involve increasing hydro capacity at existing hydro sites. The sites remaining can generally be categorized as low-head, that is, the fall available to generate power is less than 60 feet. Only about 20 undeveloped sites remain in consideration. These are sites where no structure (dam) exists now. The sites remaining for consideration can be categorized as indicated below.

Corps of Engineers Developed Multi-Purpose Projects

This group represents the largest portion of remaining sites and includes about 60 of the 194 sites considered. These sites generally have been developed for flood control, recreation, and in many cases water supply or water quality. Most of these sites could operate to meet seasonal and daily fluctuations in power demand. About 20 of these 60 sites have localized potential only. Generally these sites have higher available power heads compared to other sites in the plan. Photographs of representative sites in this group are provided as Figures 7.1, 7.2 and 7.3.

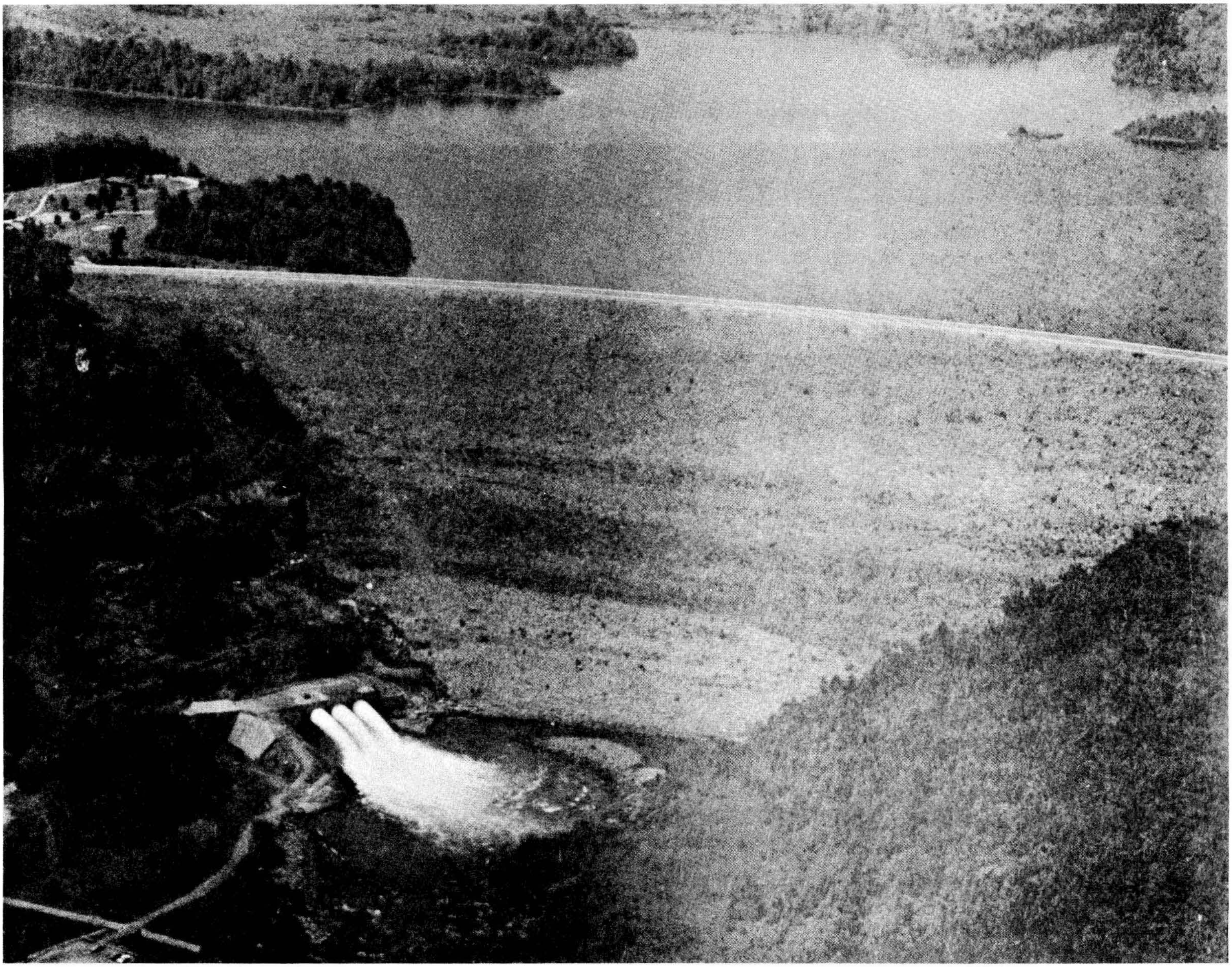


Figure 7-1
CORPS OF ENGINEERS MULTI-PURPOSE PROJECT DESIGNATED AS NEAR-TERM HIGH
(SUMMERSVILLE, WV)

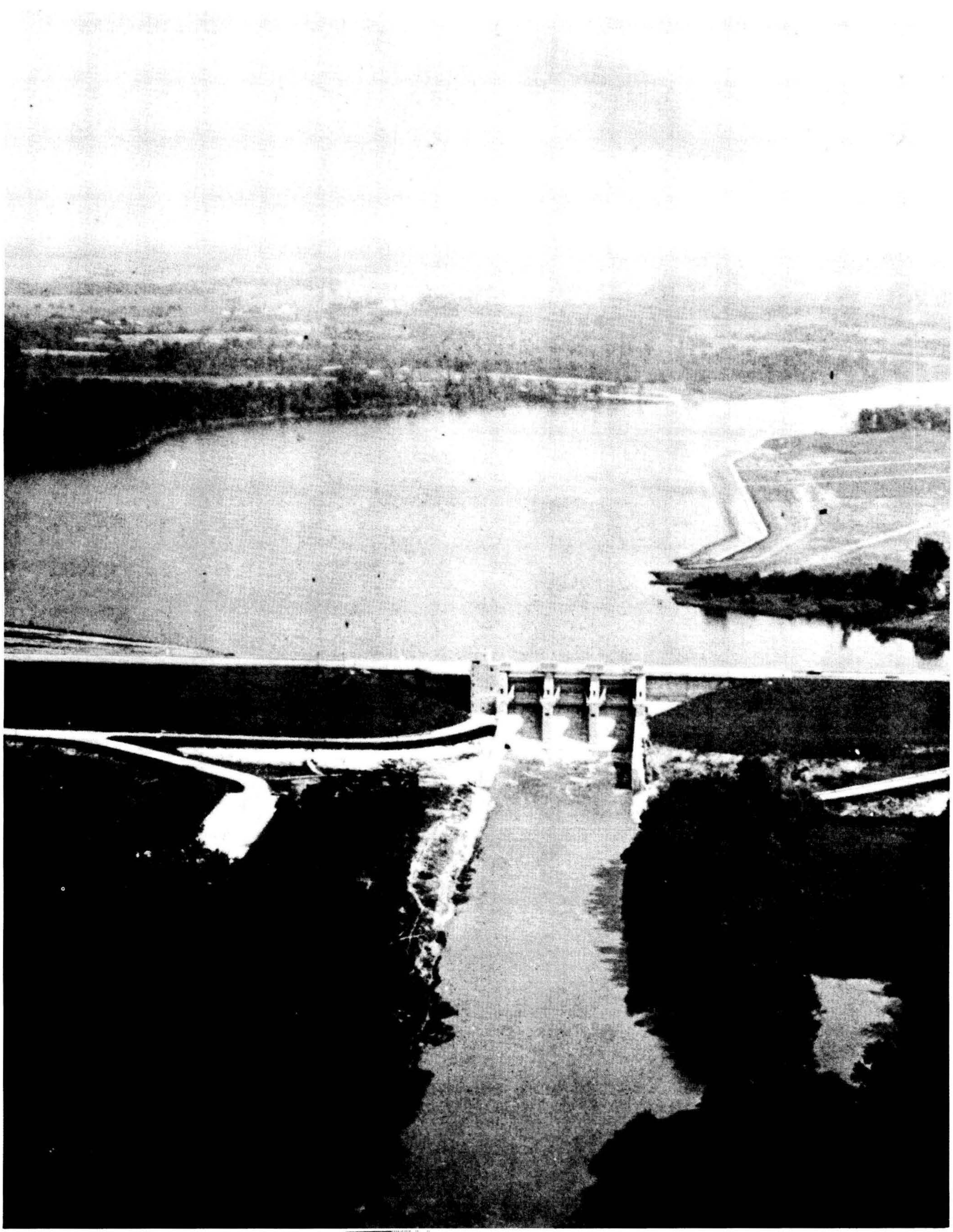


Figure 7-2
CORPS OF ENGINEERS MULTI-PURPOSE PROJECT DESIGNATED AS NEAR-TERM HIGH
(HUNTINGTON, IN)

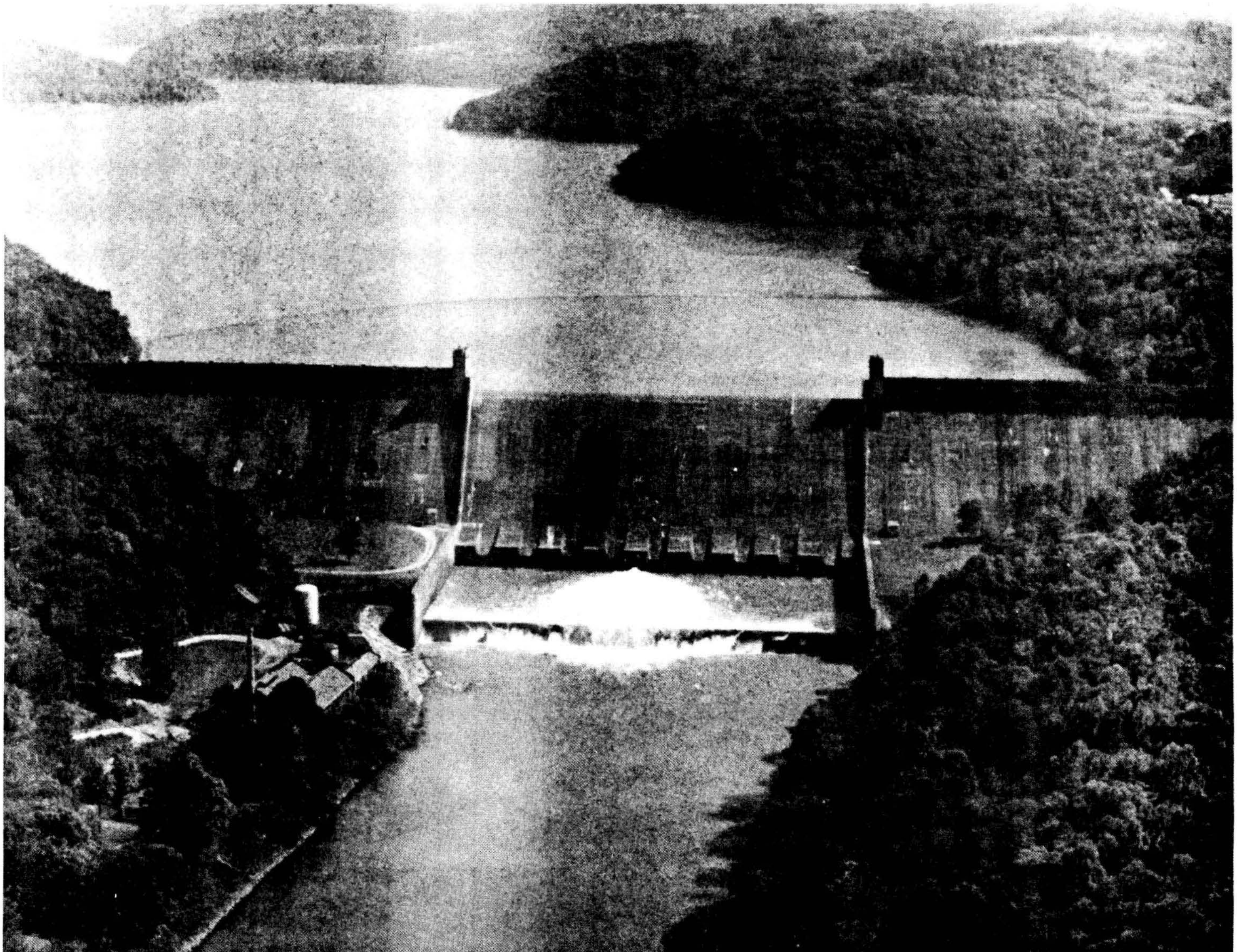


Figure 7-3
CORPS OF ENGINEERS MULTI-PURPOSE PROJECT DESIGNATED AS NEAR-TERM HIGH
(TYGART, WV)

Corps of Engineers Developed Navigation Projects

Fifty-four of the 194 sites are in this category including the Corps-owned navigation locks and dams on the Ohio, Allegheny, Monogahela, Kanawha, Kentucky, Green, and Barren Rivers. These sites, if developed, would generally be operated in a "run-of-river" mode with little pondage or storage capability and relatively low power heads. Because of these constraints, these projects would generally not operate to address peak demands. However, additional studies of a "system" type could determine that groups of these projects, such as those on the Ohio River, could be operated in a coordinated manner resulting in greater potential to meet peak demands. Many of these projects were constructed to accommodate hydro facilities at a later date. Representative photographs of projects in this group are provided as Figures 7.4 and 7.5.

Non-Federally Owned Single Purpose Projects

About 20 sites are included in this category. These sites are owned by state agencies, municipalities, private companies, or individuals and typically have low power heads, little storage capability and were constructed generally for a single purpose such as recreation or water supply. Many of these sites have localized potential only.

Included within this group are the Muskingum River Locks and Dams owned by the State of Ohio and now used primarily for recreational boating navigation purposes. The Muskingum projects also have "system" potential if developed on a coordinated basis. Figures 7.6 and 7.7 illustrate this group of projects.

Existing Hydropower Projects With Incremental Potential

Nearly all of the sites in this group are owned by private companies and most are located in Michigan and Virginia. Most of the Michigan sites are in this category. Sites in this category have hydropower potential in addition to what is now produced at the site. This potential could be realized through addition of facilities or upgrading of existing facilities. While many of these sites have potential which is only marginally economic at this time, additional capacity could be added later in the planning period as it becomes more economically attractive.

Undeveloped Sites

About 20 undeveloped sites remain in the inventory of 194 sites. These are sites where no structure or project of any type exists now. Most of these sites are in various stages of feasibility studies and most are sites considered for development by the Corps of Engineers as multi-purpose projects with hydro as a purpose. While these sites often are those with the highest potential capacity, they would also take the longest time for development.

These 194 sites remaining after the Stage 4 screening process constitute the inventory of sites for inclusion in the regional plan.

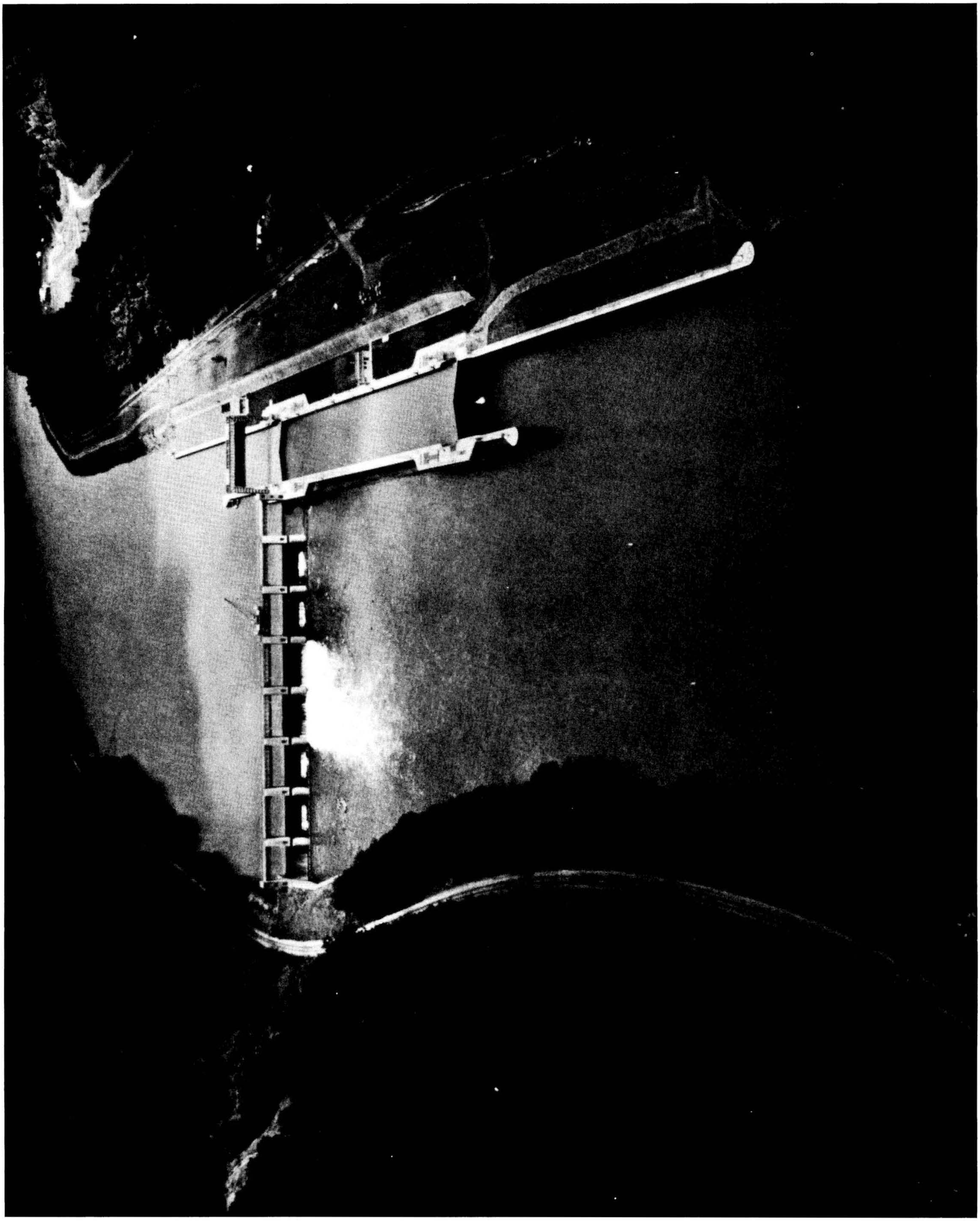


Figure 7-4
CORPS OF ENGINEERS LOWHEAD NAVIGATION PROJECT DESIGNATED AS NEAR-TERM OTHER
(HILDERBRAND L&D, WV)

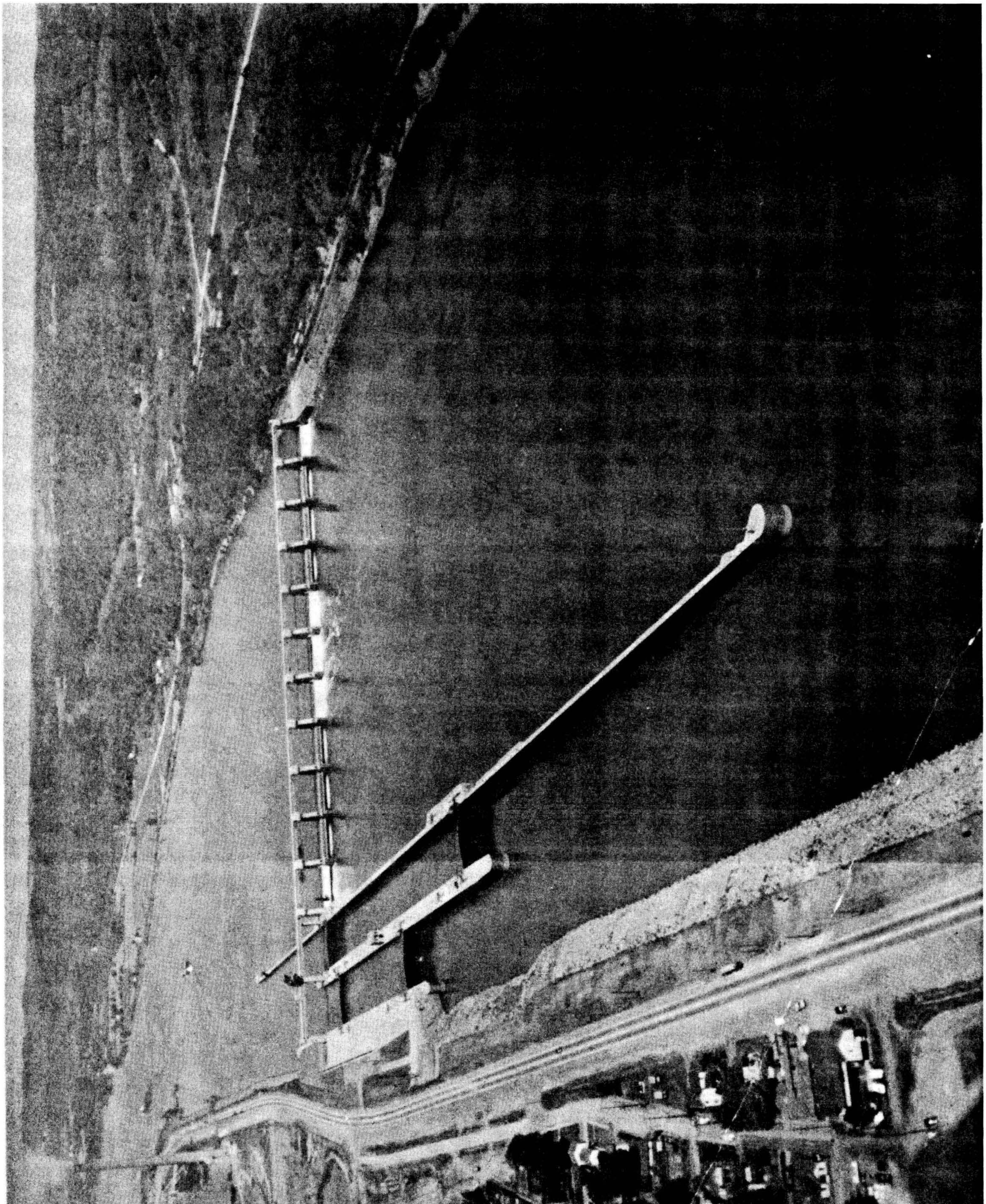


Figure 7-5
CORPS OF ENGINEERS LOWHEAD NAVIGATION PROJECT
OHIO RIVER MAINSTEM, (NEW CUMBERLAND, OH L&D)

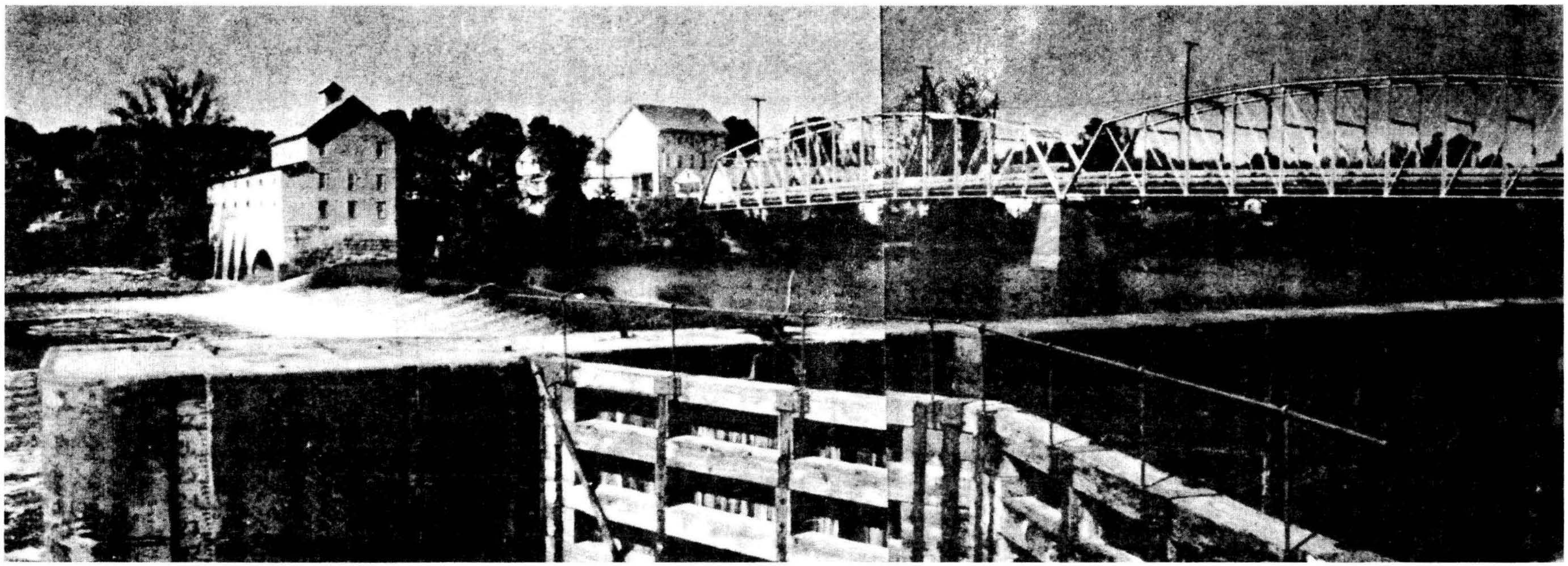


Figure 7-6
NON-FEDERALLY OWNED SINGLE PURPOSE PROJECT
MUSKINGUM R. LOCK & DAM NO. 6—OWNER, STATE OF OHIO

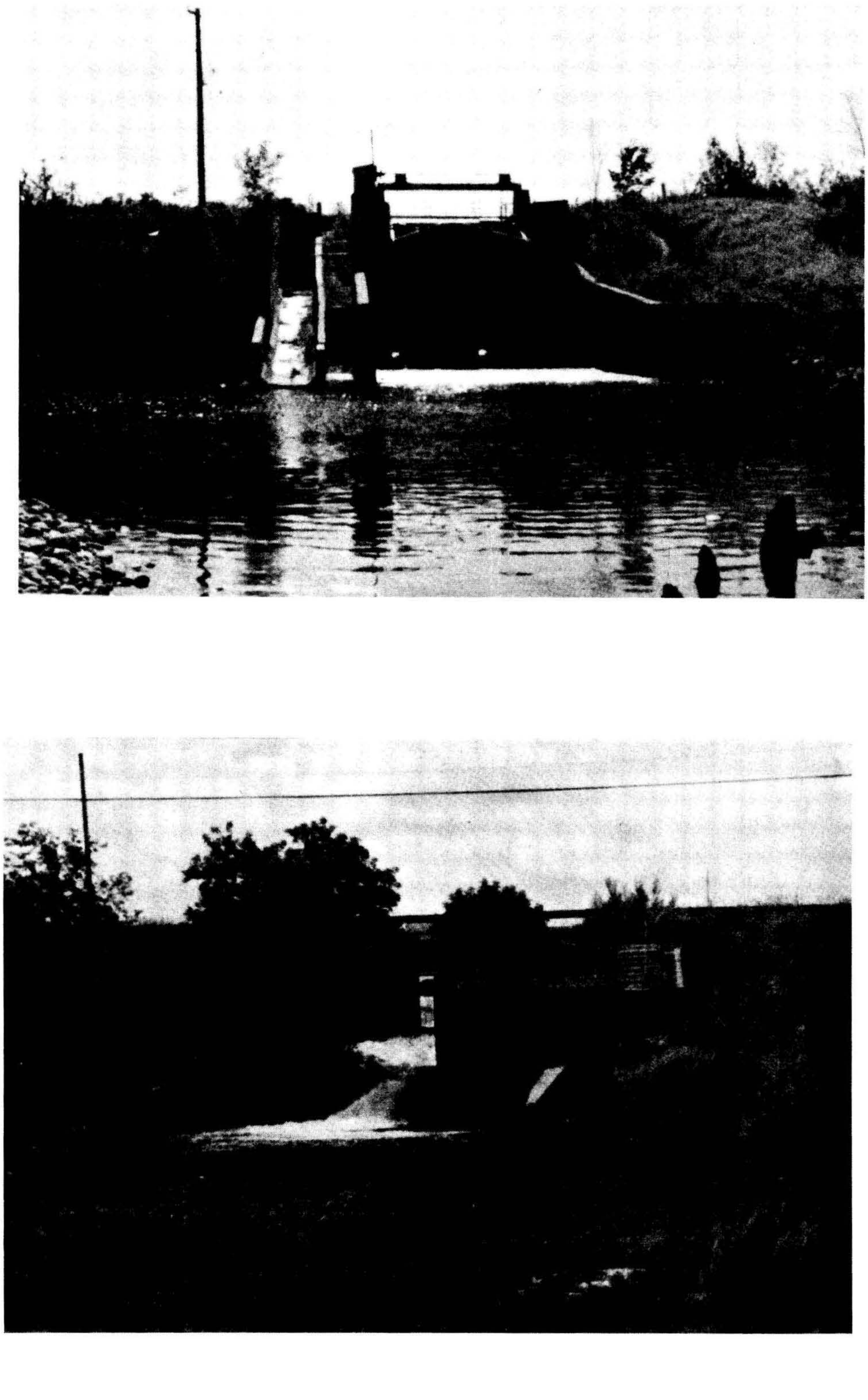


Figure 7-7
NON-FEDERALLY OWNED SINGLE PURPOSE PROJECT
LOCALIZED POTENTIAL (MICHIGAN)

Chapter 8
EVALUATION

8.1 PLAN FORMULATION OBJECTIVES

Supply and demand and site evaluation study findings are reflected in the objectives for developing a regional plan. The objectives are:

- To develop all acceptable sites. It is apparent from comparing the amount of potential new hydro capacity and energy available for development in ECAR to the anticipated demands for electric power shown in Chapter 4 of this report, that any hydroelectric facility which can compete economically with other power sources can be utilized by the ECAR region. With ECAR peak demand projected to be about 130,000 megawatts by the year 2000, and ECAR's existing capacity at about 80,000 megawatts, the several thousand megawatts of potential hydro capacity identified, if fully developed, would not close the capacity gap.

- To put a higher priority on sites which can displace oil. In 1977, the ECAR region used nearly 30 million barrels of distillate, residual crude oil to generate electric power. Some of this oil was used to meet peak power demands which could not be met by other types of facilities such as coal and nuclear. Accordingly, potential hydro sites which can be operated to meet peak demands and compete with oil-fired facilities would be given a higher priority for development over sites which cannot. The hydro site which has significant reservoir storage and can release water for power on a flexible basis during periods of peak demand would be given a higher priority than a site with little storage capacity which releases water as it flows down the river and cannot store its power output for periods of peak demand.

- To develop hydro at existing dams first. Retrofitting of hydro to existing dams represents an opportunity to capture energy presently wasted in the form of falling water. Retrofits can probably be accomplished in a shorter time frame than undeveloped sites since the major construction and real estate acquisition tasks have already been completed. While alteration of an existing dam's operation to accomodate hydro may create impacts on the environment, these impacts are not of the magnitude associated with constructing a dam and impounding a lake at an undeveloped site and can readily be addressed.

- To avoid degradation of existing project functions. If it is preferable to develop hydro at existing dams before building new ones, it is also recognized that hydro cannot be added without regard to the existing purposes of the dam. Navigation, flood control, water supply, fish and wildlife, instream flows, and recreation will all compete for the use of water and hydropower cannot be developed when it would unacceptably alter these other project purposes.

8.2 PLAN FORMULATION CRITERIA

Evaluation of probable requirements and procedures for developing potential sites provides a basis for establishing four time frame plan categories.

- The near term category includes projects which could be operational by year 1990.

- The mid term category includes projects which could be operational in the 1990 to 1995 time frame.

- The long term category involves sites to be developed after year 1995 and includes most undeveloped sites.

- The remaining category of localized potential involves sites with capacity in the range of 1 megawatt. Sites with localized potential could be developed in any time frame.

Hydro sites within ECAR are relatively limited and widely dispersed and could be developed by a variety of interests. These characteristics suggest that framework rather than site specific priorities are appropriate.

Accordingly, two priority categories were established. Sites are prioritized as "high" or "other." "High" priority sites are judged to have the potential to be operated on a flexible basis to supply peak demands. "Other" priority sites are judged to have very little capability for flexible operation and can be characterized as "run-of-river" facilities.

Appendix A lists potential hydropower sites included in the ECAR regional plan, and utilizes a numerical code to identify a site's priority and time frame for development.

Sites with code:

1001--high priority sites which could be developed by 1990
1002--other priority sites which could be developed by 1990
2003--high priority sites which could be developed by 1995
2004--other priority sites which could be developed by 1995
2005--all sites which could be developed after 1995
2010--sites with localized potential which could be developed at any time.

8.3 ALTERNATIVE PLANS

Current plan formulation practice includes consideration of alternative plans which emphasize economic efficiency, environmental quality, and other regionally important objectives such as oil displacement. Since the screening processes accomplished during Stages 1, 2, and 3 eliminated economically inefficient and environmentally unacceptable sites to the extent practicable with regional scope studies, alternative plan concepts considered during Stage 4 primarily involved variations in the scale of development and operational characteristics of individual sites.

Four alternative plan concepts were identified as follows:

- A plan which maximizes energy output would include all existing dams and potential dam sites advanced to Stage 4. Within the constraint of marginal economic feasibility, individual sites would be developed at the largest practicable scale.

- A plan which maximizes economic efficiency would include most sites advanced to Stage 4. Individual sites would be developed and operated to maximize net return on investment.

- A plan which emphasizes environmental quality would include most existing dams advanced to Stage 4. Individual site development and hydro operations would be oriented toward avoiding localized environmental losses and, where practicable, achieving environmental enhancements.

- A plan concept, which subsequently evolved as the recommended regional plan, would involve a balanced consideration of energy output, and environmental quality. Such a trade-off plan would provide more energy than hydro plans oriented toward environmental quality and economic efficiency but at less economic and regional environmental costs than fossil fuel and nuclear alternatives.

8.4 DESCRIPTION OF THE REGIONAL PLAN

The regional plan reflects the concept described as the 4th alternative of "trade-off plan" and includes 194 sites.

Tables 8.1 through 8.4 present pertinent characteristics of the 194 sites listed in Appendix A, the regional plan.

Table 8-1
SUMMARY OF ECAR REGIONAL PLAN SITES BY STATE AND PLAN DESIGNATION

Plan Designation	IN	KY	MD	MI	OH	PA	VA	WV	*ORM	Total
Near Term										
High	5	10	1	0	6	6	4	4	0	36
other	1	6	0	6	12	14	3	4	18	64
Mid term										
High	2	11	0	0	0	2	1	2	0(18)*	18(36)*
Other	0	0	2	2	4	0	2	3	0	13
Long Range	4	5	0	2	0	3	4	5	0	23
Localized Potential										
Federal	1	2	0	0	14	0	1	3	0	21
Others	1	1	1	9	2	2	1	2	0	19
Total	14	35	4	19	38	27	16	23	18	194

*Ohio River Mainstem Navigation Projects

More than half of the sites in the plan could be developed by 1990. Forty-two of the 194 sites have relatively small potential, in the range of 1 megawatt, and could be developed in any time frame. The 23 sites designated long range are primarily undeveloped, with no existing structure.

All of the sites listed under the ORM column are navigation structures on the Ohio River and on an individual basis are designated as near term run-of-river potential. Current non-Federal efforts for developing the near term increment of hydro potential at the 18 high lift navigation projects on the main stem of the Ohio River indicate an average capacity of 57 megawatts for the 18 projects. Preliminary computations of energy potential and hydro development costs at these high lift projects were accomplished during the National Hydro Study. These computations and application of the generalized energy and capacity values furnished by FERC indicated that substantially larger installations are economically feasible. However, determination of optimum energy development is dependent upon relatively detailed evaluation of potential impacts on the navigation system and the resource values of the Ohio River. Pending completion of these system studies, a gross estimate of incremental mid term capacity development potential, equivalent to about 50 percent of near term capacity development, has been utilized for the regional plan.

On a state-by-state basis, those states located wholly within ECAR such as Ohio and Kentucky have the most sites within the plan. Michigan's sites are all of the "run-of-river" type as opposed to other states such as Indiana and Kentucky which have predominately high priority load following sites.

Table 8.2 presents a breakdown of sites by potential capacity size.

Table 8-2
ECAR REGIONAL PLAN SITES BY POTENTIAL CAPACITY AND STATE

Potential Capacity (MW)	IN	KY	MD	MI	OH	PA	VA	WV	*ORM	TOTAL
100+	0	1	0	0	0	1	0	3	1	6
50-99	0	1	0	0	0	1	1	4	9	16
25-49	0	1	0	0	0	0	1	1	7	10
15-24	0	7	0	0	2	10	5	3	1	28
10-14	3	1	1	0	1	5	0	2	0	13
5-9	3	10	0	2	6	2	4	2	0	29
1-4	6	11	2	8	13	6	3	3	0	52
Localized Potential	2	3	1	9	16	2	2	5	0	40
TOTAL	14	35	4	19	38	27	16	23	18	194

*Ohio River Mainstem

Most potential sites can be categorized as small-scale. More than 80 percent have less than 25 megawatts potential capacity. Those above 25 megawatts are predominantly Ohio River navigation structures or undeveloped sites. The larger non navigation structure sites are mostly in the eastern part of ECAR where terrain is more mountainous and precipitation greater. West Virginia has the largest proportion of sites over 25 megawatts excluding Ohio River main stem sites.

Of the 194 sites, 114 are Corps of Engineers existing projects. Private companies, primarily utilities, own 35 sites which are existing projects. Of the remaining sites, 29 are existing projects owned by states, municipalities or other government agencies, and the remaining 16 sites are undeveloped with no existing structures.

Table 8.3 presents a summary of hydropower potential at the 178 sites where hydro could be added to an existing project. This summary is also provided by site plan designation and project ownership. Potential at undeveloped sites is presented in Table 8.4.

Table 8-3
HYDROPOWER POTENTIAL OF ECAR REGIONAL PLAN SITES
(HYDRO ADDED TO EXISTING STRUCTURE)

	Near Term High	Near Term Other	Mid Term High*	Mid Term Other	Long Range	Total
Ownership						
Corps of Engineers						
Capacity (MW)	530.0	1280.0	668.0	40.0	170.0	2688.0
Annual Energy (GWH)	1270.0	5790.0	2106.0	160.0	500.0	9826.0
Others						
Capacity (MW)	20.0	90.0	2.0	70.0	30.0	212.0
Annual Energy (GWH)	50.0	350.0	4.0	170.0	220.0	794.0
All						
Capacity (MW)	550.0	1370.0	670.0	110.0	200.0	2900.0
Annual Energy (GWH)	1320.0	6140.0	2110.0	330.0	720.0	10620.0

*Includes system potential of Ohio River main stem sites.

NOTE: Table excludes localized potential sites.

Table 8-4
HYDROPOWER POTENTIAL OF ECAR REGIONAL PLAN SITES
(UNDEVELOPED SITES)

	Plan Designation					
	Near Term High	Near Term Other	Mid Term High	Mid Term Other	Long Range	TOTAL
Capacity (MW)	0	0	200.0	90.0	1250.0	1540.0
Annual Energy (GWH)	0	0	380.0	200.0	1960.0	2540.0

Nearly 3000 megawatts of potential new hydro capactiy could be in operation in ECAR by adding hydro facilities to existing dams. Over 500 megawatts of this potential can be added in the near term, before 1990. While the undeveloped sites number less than 10 percent of the sites in the plan, they account for over one-third of the potential new capacity.

8.5 Plan Implementation

Implementation of the variety of projects within the tentative regional plan could involve many different interests. Existing Federal and state project might be developed by public agencies. Subject to owner consent, any project in the regional plan could be developed by a major investor owned utility, or a municipality or an electric cooperative. Also, any other organization with sufficient resources and capabilities could be a potential hydro developer.

Implementation procedures would be a function of the type of project and involved developer. Federal development of an existing Federal project would require Congressional authorization. Non-Federal developers would be require to comply with the Federal Energy Regulatory Commission's (FERC) licensing procedures. In this regard, FERC is streamlining its licensing procedures tc encourage hydro development at existing projects.

In certain cases, the Department of Energy and other agencies may provi(financial incentives to stimulate hydro development. Also, the Congress is considering additional legislation which would facilitate and streamline hyd development procedures by both the public and private sectors.

Regardless of the implementation entity, the next basic step toward implementation is a more detailed planning study of individual sites. Sucl planning should consider development options such as the following four bas: plan variations.

- The plan which maximizes net return on investment based upon an economic quantification of all associated costs and benefits.

- The plan which maximizes energy output scaled to a high level of development which results in break even return on investment.

- The plan which maximizes useful energy output without resulting in significant long term environmental degradations in comparison to most probable future conditions without hydro development.

- A trade-off plan with high energy output without significant advers impacts upon existing project functions and resource values and scaled to a high practical level of development.

Evaluation of potential projects within ECAR indicates that refinemen of trade-off plans for addition of hydro facilities to existing dams shoul reflect the following key planning considerations:

Public safety
Integrity of existing project functions
Fluctuation of lake levels
Fluctuation of downstream flows

The critical structural function of existing dams is to safely impound a volume of water. Thus, public safety is a primary consideration when existing dams and appurtenances are modified to provide for addition of hydroelectric facilities. The degree of public safety considerations will vary in accordance with the height and physical characteristics of existing dams and downstream developments. Risks associated with addition of hydro facilities to the several low head dams within the regional plan are relatively moderate. However, the regional plan also includes several intermediate and high head dams which impound large volumes of water. Failure of one of these structures could result in catastrophic damages and loss of life. Accordingly, structural modifications must be based upon conservative design criteria and construction procedures to assure public safety.

Functions of existing projects within the regional plan vary from single purposes such as water supply and recreation to more complex multiple purpose facilities which provide flood control, water supply, recreation, and downstream base flow stabilization services. The complexity of planning efforts required to determine an optimum hydroelectric addition usually will depend on the complexity of existing project functions. Generally, established functions must be maintained at a level which will avoid consequential degradation of existing services. However, maintaining existing project functions does not necessarily preclude adjustments in storage allocations and operating regimes where it can be demonstrated that such adjustments will not degrade existing services and will improve hydroelectric power performance. Evaluation of such adjustments will entail a rigorous planning effort and may require enabling legislation for additions to existing public projects.

Most of the existing dams in the regional plan create recreational lakes which could be adversely affected by fluctuations associated with hydroelectric operations. Affected projects can be placed into three general categories:

Non-Federal developed recreation lakes
Federally developed navigation pools
Federally developed multiple purpose lakes

Liaison with state natural resources agencies indicates that very stringent restraints on fluctuations would be required at state developed recreation lakes.

Daily fluctuation of navigation pool levels could have significant impacts on commercial navigation, fishery, and other project services. Pending accomplishment of a detailed study of potential hydroelectric pondage operations on the Ohio River and other regional navigation systems, near term development of "run-of-river" type hydro installations is appropriate. It is essential that such initial installations are designed to allow efficient development of additional hydroelectric capacity at a later date when system studies are complete.

Pool fluctuation criteria for Federally developed multi-purpose lakes generally must be determined on a case by case basis. In addition to Federal investments, state agencies and licensees, such as marina operators, have made major investments in recreational facilities and fishery improvements at many projects and would be fully involved with Federal interests in formulating pool level criteria. Design criteria should include appropriate limitations on daily lake fluctuations and frequency of reservoir draw-down and filling during the recreational season.

Daily and seasonal fluctuation of lakes and pools will result in corresponding variations in downstream flows. Information evolving from more detailed studies of hydro additions to existing multipurpose projects indicates that environmental design criteria to protect downstream resource values may be the primary constraint on hydro operations. Such environmental design criteria must reflect consideration of impacts upon recreation, fisheries, water quality, aesthetics, and stream bank stability. Resulting criteria should establish minimum and maximum daily flows, allowable rates of change of turbine discharges, and maximum daily variation in river stages. In addition to the preceding key planning considerations, identification and incorporation of potential significant positive impacts of hydropower development, such as improved downstream fishing, would be a part of the planning process.

Detailed planning efforts should identify and fully evaluate other significant project features and resource values. This approach, and comprehensive environmental impacts assessments, will insure that the regional objective "to avoid degradation of existing project functions and resource values" is achieved.

Chapter 9
FINDINGS AND CONCLUSIONS

9.1 EXISTING SUPPLY AND DEMAND

Coal is the dominant source (80 percent) and hydroelectric is a nominal source (1 percent) of electric energy within ECAR. ECAR is in substantial variation from national percentages which reflect much higher levels of oil, gas, hydro, and nuclear utilization.

While ECAR enjoys close proximity to its major source of fuel, it experiences a related high rate of unavailable generating capacity because coal-fired generating equipment generally requires more maintenance and repairs than oil, gas, or hydro turbines. On a typical week day, an average of 21 percent of ECAR's generating capacity is unavailable for service. With such relatively high outage rates, the 84,000 megawatts of generating capacity within ECAR only slightly exceeds peak demand conditions.

Demand for electricity within ECAR varies substantially on a seasonal, weekly, and daily basis. Summer air conditioning and winter heating needs result in peak seasonal demands, and weekday consumption exceeds weekend consumption. Also, significant demand fluctuations occur within a normal 24 hour period

Typical large coal-fired generating facilities in ECAR operate most efficiently at a constant and relatively high rate of energy output. Also, such units operate at high temperatures and cannot be readily turned on and off as electric demand varies.

Conversely, the operation of oil, gas, and hydro turbines can be varied quite rapidly. Accordingly, oil- and gas-fired combustion turbines are utilized within ECAR to satisfy some peak demand fluctuations.

Oil utilization within ECAR is about 30 million barrels a year. In concert with continuing emphasis on savings of non renewable resources, efforts are underway to convert some oil-fired facilities to other fuels.

9.2 PROJECTED CONDITIONS

Current emphasis on conservation and load management within ECAR may significantly reduce growth in demand for electricity. The minimum increase in electric demand which is likely to occur would be a rate of increase at about 1/2 the actual rates experienced in the 1950's and 60's.

For these low range demand conditions, total annual demand for energy is expected to increase from about 370 million megawatt-hours in 1978 to 637 million megawatts in 1995. Peak demand is projected to increase from about 63 thousand megawatts to about 112 thousand megawatts during the same period.

The sources of electric energy within ECAR are not anticipated to change significantly over the next 10 to 15 years. Coal will continue to be the dominant source of energy within ECAR. Oil utilization could increase slightly or decline depending on the effectiveness of efforts to develop alternative means of satisfying or eliminating peak power demand fluctuations.

The one percent of ECAR's energy provided by conventional hydroelectric facilities could increase or decrease depending upon the intensity of effort to develop available hydro sites. However, ECAR does not contain sufficient hydro potential to offset the need for concerted conservation efforts and development of additional thermal generating capacity.

9.3 PLAN IMPLEMENTATION

Implementation of the nearly 200 hydro sites in the regional plan for ECAR could be accomplished by many different interests including public agencies, investor owned utilities, municipalities, electric cooperatives, and project owners. However, procedural implementation requirements will vary from nominal to highly complex efforts depending upon the specific site involved.

With some exceptions, existing low head single purpose dams generally provide the simplest opportunity for hydro development while high head multiple purpose dams will entail the most complex detailed planning and design efforts. The primary exception to streamlined development of low head dams is hydroelectric peaking operations at Federally developed locks and dams, which are vital components of commercial navigation systems.

The regional plan is responsive to potential impacts of peaking operations on commercial navigation and other waterway resource values. It provides for near-term development of primarily "run-of-river" type hydroelectric facilities while deferring development for significant peaking operation to the mid term time frame. Depending upon the availability of funds, this time phasing will provide the Corps of Engineers with an opportunity to accomplish detailed evaluations of the impacts and acceptability of hydroelectric peaking operations on commercial navigation systems and subsequent case by case decisions on significant hydro pondage at individual projects.

9.4 GUIDELINES FOR DETAILED PLANNING

Detailed planning of hydro development at individual sites within ECAR should be oriented toward development of a plan which maximizes peak energy output without significant adverse impact upon existing project functions and resource values. Key planning considerations should be public safety, integrity of existing project functions, and the physical and environmental effects of fluctuation of lake levels and downstream flows.

Physical risks associated with addition of hydro facilities to the several low head dams within the regional plan are relatively moderate. However, structural modifications to dams which impound large volumes of water must be based upon conservative design criteria and construction procedures to assure public safety.

Generally, established project functions must be maintained. However, this requirement does not necessarily preclude adjustments in storage allocations and operating regimes where it can be demonstrated that such adjustments will not significantly degrade existing services and resource values and will improve hydroelectric power performance. Adjustments of project storage allocations and functions may require enabling legislation for existing Federal projects.

Most of the existing dams in the regional plan create recreational lakes which could be adversely affected by fluctuations associated with hydroelectric operations. Pool fluctuation criteria for established lakes and navigation pools generally can be derived on a case by case basis. Design criteria should include appropriate limitations on daily lake fluctuations and frequency of reservoir drawdown and filling during the recreational season. Also, critical short term conditions such as special requirements for the spawning and nesting of native fishery and waterfowl must be fully considered.

Daily and seasonal fluctuation of lakes and pools will result in corresponding variations in downstream flows. Impacts upon recreation, fishery, water quality, aesthetics, and stream bank stability must be considered. Environmental design criteria should include minimum and maximum daily flows, allowable rates of change in turbine discharges, and maximum daily variation in river stages. Where required, physical facilities adversely affected by pool fluctuations, would be replaced, and losses of natural resource values due to alterations in pool and lake levels would be mitigated in a fair and reasonable manner.

9.5 FUTURE ROLE OF HYDRO

About 3000 megawatts of additional hydro capacity could be developed in ECAR by adding facilities to existing dams. This additional capacity could play an important role in ECAR's energy future by:

- improving system reliability;
- increasing system flexibility;
- reducing use of critical non-renewable resources:
- providing an emergency reserve; and
- contributing significant new sources of energy to the smaller systems within the ECAR region.

GLOSSARY

Abbreviations

British thermal units	Btu	kilowatt	kW
dollars	$	kilowatt-hours	kWhr
gigawatt	GW	megawatt	MW
gigawatt-hours	GWhr	megawatt-hours	MWhr

AVERAGE LOAD-the hypothetical constant load over a specified time period that would produce the same energy as the actual load would produce for the same period.

BENEFIT-COST RATIO (B/C)-the ratio of the present value of the benefit stream to the present value of the project cost stream computed for comparable price level assumptions.

BENEFITS (ECONOMIC)-the increase in economic value produced by a project, typically represented as a time stream of value produced by the generation of hydroelectric power.

BRITISH THERMAL UNIT (Btu)-the quantity of heat energy required to raise the temperature of 1 pound of water degree Fahrenheit, at sea level.

BUS-an electrical conductor which serves as a common connection for two or more electrical circuits. A bus may be in the form of rigid bars, either circular or rectangular in cross sections, or in form of stranded-conductor overhead cables held under tension.

BUSBAR-an electrical conductor in the form of rigid bars, located in switchyard or powerplants, serving as a common connection for two or more electrical circuits.

CAPACITY-the maximum power output or load for which a turbine-generator, station, or system is rated.

CAPACITY VALUE-that part of the market value of electric power which is assigned to dependable capacity.

COSTS (ECONOMIC)-the stream of value required to produce the project output. In hydro projects this is often limited to the management and construction cost required to develop the powerplant, and the administration, operations, maintenance and replacement costs required to continue the powerplant in service.

CRITICAL STREAMFLOW-the amount of streamflow available for hydroelectric power generation during the most adverse streamflow period.

DEMAND-see LOAD.

DEPENDABLE CAPACITY-the load carrying ability of a hydropower plant under adverse hydrologic conditions for the time interval and period specified of a particular system load.

DIVERSION-the removal of streamflow from its normal water source such as diverting flow from a river for purposes such as power generation or irrigation.

DRAFT TUBE-that section of the turbine water passage which extends from the discharge side of the turbine runner to the downstream extremity of the powerhouse structure.

ENERGY-the capacity for performing work. The electrical energy term generally used is kilowatt-hours and represents power (kilowatts) operating for some time period (hours).

ENERGY VALUE-that part of the market value of electric power which is assigned to energy generated.

FEASIBILITY STUDY-an investigation performed to formulate a hydropower project and definitively assess its desirability for implementation.

FEDERAL ENERGY REGULATORY COMMISSION (FERC)-an agency in the Department of Energy which licenses non-Federal hydropower projects and regulates interstate transfer of electric energy. Formerly the Federal Power Commission (FPC).

FIRM ENERGY-the energy generation ability of a hydropower plant under adverse hydrologic conditions for the time interval and period specified of a particular system load.

FORCED OUTAGE-the shutting down of a generating unit for emergency reasons.

FORCED OUTAGE RATE-the percent of scheduled generating time a unit is unable to generate because of forced outages due to mechanical, electrical or another failure.

FOREBAY-this generally refers to the reservoir area located immediately upstream of a dam or powerhouse.

FOSSIL FUELS-refers to coal, oil, and natural gas.

GENERATOR-a machine which converts mechanical energy into electric energy.

GIGAWATT (GW)-one million kilowatts.

HEAD, GROSS (H)-the difference in elevation between the headwater surface above and the tailwater surface below a hydroelectric powerplant, under specified conditions.

HORSEPOWER-mechanical energy equivalent to 550 ft. lbs. per second of work.

HYDROELECTRIC PLANT OR HYDROPOWER PLANT-an electric power plant in which the turbine-generators are driven by falling water.

IMPOUNDMENTS-bodies of water created by erecting a barrier to flow such as dams and diversion structures.

INSTALLED CAPACITY-the total of the capacities shown on the nameplates of the generating units in a hydropower plant.

INTAKE STRUCTURE-a concrete structure arranged to control the flow of water from a reservoir to the ultimate point of use. This structure usually contains either intake gates, or large valves, for regulating the rate of flow and for shutoff purposes.

KILOWATT (kW)-one thousand watts.

KILOWATT-HOUR (kWh)-the amount of electrical energy involved with a one kilowatt demand over a period of one hour. It is equivalent to 3,413 Btu of heat energy.

LOAD-the amount of power needed to be delivered at a given point on an electric system.

LOAD CURVE-a curve showing power (kilowatts) supplied, plotted against time of occurrence, and illustrating the varying magnitude of the load during the period covered.

LOAD FACTOR-the ratio of the average load during a designated period to the peak or maximum load occurring in that period.

LOW HEAD HYDROPOWER-hydropower that operates with a head of 20 meters (66 feet) or less.

MEGAWATT (MW)-one thousand kilowatts.

MEGAWATT-HOURS (MWh)-one thousand kilowatt-hours.

MULTIPURPOSE RIVER BASIN PROGRAM-programs for the development of rivers with dams and related structures which serve more than one purpose, such as - hydroelectric power, irrigation, water supply, water quality control, and fish and wildlife enhancement.

NUCLEAR POWER-power released from the heat of nuclear reactions, which is converted to electric power by a turbine-generator unit.

OPERATING POLICY (Operating Rule Curves)-the technical operating guide adopted for water resources projects to assure that authorized output of the project is achieved. Usually in the form of charts and graphs of reservoir release rates for various operational situations.

OUTAGE-the period in which a generating unit, transmission line, or other facility, is out of service.

PEAK LOAD-the maximum load in a stated period of time.

PEAKING CAPACITY-the part of a system's capacity which is operated during the hours of highest power demand.

PENSTOCK-a large water conduit which is subjected to high internal pressure and is fully self-supporting.

PLANT FACTOR-ratio of the average load to the installed capacity of the plant, expressed as an annual percentage.

PONDAGE-the amount of water stored behind a hydroelectric dam of relatively small storage capacity used for daily or weekly regulation of the flow of a river.

POWER (ELECTRIC)-the rate of generation or use of electric energy, usually measured in kilowatts.

POWER POOL-two or more electric systems which are interconnected and coordinated to a greater or lesser degree to supply, in the most economical manner, electric power for their combined loads.

PUMPED STORAGE-an arrangement whereby electric power is generated during peak load periods by using water previously pumped into a storage reservoir during off-peak periods.

REALLOCATION-the concept of changing the existing distribution in use of reservoir storage space to a new distribution. Reallocation of flood control storage to power storage would reduce reservoir storage space reserved for temporary storage of flood water and increase the conservation storage available for power operation.

RECONNAISSANCE STUDY-a preliminary feasibility study designed to ascertain whether a feasibility study is warranted.

REVERSIBLE PUMP TURBINE-a Francis type hydraulic turbine which is designed to operate a pump in one direction of rotation, and as a turbine in the opposite direction of rotation. Good efficiencies can be achieved with both modes of operation.

RUNNER BLADES-the propeller like vanes of a hydraulic turbine which convert the kinetic energy of the water into mechanical power.

SECONDARY ENERGY-all hydroelectric energy other than FIRM ENERGY.

SPINNING RESERVE-generating units operating at no load or at partial load with excess capacity readily available to support additional load.

STEAM-ELECTRIC PLANT-a plant in which the prime movers (turbines) connected to the generators are driven by steam.

SURPLUS POWER-generating capacity which is not needed on system at the time it is available.

SYSTEM, ELECTRIC-the physically connected generation, transmission, distribution, and other faciltiies operated as an integral unit under one control, management or operating supervision.

TAILWATER LEVEL-the water level measured in the tailrace area immediately downstream from a hydro plant.

THERMAL PLANT-a generating plant which uses heat to produce electricity. Such plants may burn coal, gas, oïl, or use nuclear energy to produce thermal energy.

TRANSMISSION-the act or process of transporting electric energy in bulk.

TURBINE-the part of a generating unit which is spun by the force of water or steam to drive an electric generator. The turbine usually consists of a series of curved vanes or blades on a central spindle.

Impulse Turbines-an impulse turbine is one having one or more free jets discharging into an aerated space and impinging on the buckets of the runner, means of controlling the rate of flow, a housing and a discharge passage. The water supplies energy to the runner in kinetic form.

Reaction Turbine-a reaction turbine is one having a water supply case, a mechanism for controlling the quantity of water and for distributing it equally over the entire runner intake, and a draft tube. The water supplies energy to the runner in kinetic form.

Francis Turbine-a reaction turbine having a runner with a large number of fixed buckets, usually nine or more, to which the water is supplied in a whirling radial direction and can be designed for operating heads ranging from 50 feet to 2,000 feet.

Adjustable-Blade Propeller Turbine (KAPLAN)-a reaction turbine having a runner with a small number of blades, usually four to eight, to which the water is supplied in a whirling axial direction. The blades are angularly adjustable in the hub.

Fixed-Blade Propeller Turbine-a reaction turbine having a runner with a small number of blades, usually four to eight, to which the water is supplied in a whirling axial direction. The blades are rigidly fastened to the hub.

UNIT EFFICIENCY-the combined overall efficiency of a hydraulic turbine and its driven generator.

UPRATING-increasing the generating capacity of a hydropower plant by either replacing existing equipment with new equipment or making improvements to the existing equipment.

WATT-the rate of energy transfer equivalent to one ampere under a pressure of one volt at unity power factor.

WHEELING-transportation of electricity by a utility over its lines for another utility; also includes the receipt from and delivery to another system of like amounts but not necessarily the same energy.

NATIONAL HYDROPOWER STUDY
VOLUME XVII
EAST CENTRAL AREA ELECTRIC RELIABILITY COUNCIL

Appendix A
INVENTORY

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INVENTORY

Appendix A provides a listing, alphabetically by state and county, of the sites included in the ECAR regional plan. Information on each site is provided as follows:

Column 1--provides the site's identification number.

Column 2--1st line--provides the name of the site
2nd line--provides the location of the site by county and stream
3rd line--provides the name of the owner, DAEN indicates the Corps of Engineers

Column 3--1st line--provides latitudinal location of the site
2nd line--provides longitudinal location of the site
3rd line--provides drainage area of the watershed upstream of the site.

Column 4--1st line--provides identified purpose of an existing dam, such as recreation, hydropower, flood control (indicated by "c"), navigation, water supply (indicated by "s")
2nd line--indicates if a project is operational for the purposes indicated
3rd line--provides the average inflow at the site

Column 5--1st line--provides height of the dam
2nd line--provides maximum storage of the reservoir
3rd line--provides the available net power head

Column 6--1st line--provides existing hydro capacity
2nd line--provides potential additional capacity
3rd line--provides total potential capacity
*This data is omitted for sites designated localized potential (Code 2010)

Column 7--1st line--provides the existing annual energy output for the site
2nd line--provides the potential additional annual energy
3rd line--provides the total potential annual energy
*This data is omitted for sites designated localized potential

Column 8--This column provides the numerical code indicating a site's plan designation. An explanation of this code is provided in Section 8.2 of the report.

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV. INV.	PROJECT NAME / PRIMARY CO. -NAME OF STREAM / OWNER	LATITUDE (D M.M) / LONGITUDE (D M.M) / DR.AREA (SQ.MI)	PROJ.PURP. / STATUS / AVE. Q (CFS)	DAM HT (FT) / MX.STOR. (AC FT) / PWR. HD. (FT)	EXIST.CAP. / INC. CAP. / TOT. CAP. (KW)	EXIST.ENRG / INC.ENERGY / TOT.ENERGY (MWH)	ERC ECONOMIC / ERC NONECONOMIC / ERC COMPOSITE (SEQUENCE RANK)
INOORL0029	OAKDALE DAM	40 39.4	HR	58.0	6000	30616	
2	CARROLL - TIPPECANOE RI	86 45.2	UP	40540	0	0	
	NORTHERN IN PUBLIC SERV	1860	1600.0	45.0	0	0	2005
INCORL0033	PATOKA LAKE	38 24.0	CR	84.0	0	0	
2	DUBOIS - PATUKA RIVER	86 37.1	OP	301640	4309	6281	
	DAEN ORL	168	168.0	53.9	4309	6281	2003
INGNCE0003	ELKHART	41 42.0	H	44.0	3440	24986	
2	ELKHART - ST JOSEPH	86 0.0	OP	14000	1600	13600	
	IND-MICH ELECTRIC CO	3370	-2925.2	18.9	5040	38586	2005
INCORL0040	BROOKVILLE LAKE	39 14.8	CR	181.0	0	0	
2	FRANKLIN - EAST FORK OF	85 1.0	OP	443000	12147	24886	
	DAEN ORL	379	379.0	126.8	12147	24886	1001
INCORL0052	HUNTINGTON LAKE	40 54.4	C R	91.0	0	0	
2	HUNTINGTON - WABASH RIVER	85 28.0	OP	170000	7130	13983	
	DAEN ORL	707	707.0	49.3	7130	13983	1001
INOORL0500	WILLIAMS DAM	38 47.9	RS	25.0	0	0	
2	LAWRENCE - EAST FORK WHI	86 38.7	UP	3000	8100	32100	
	IND. DEPT. NATURAL RESOURCES	4690	4600.0	20.9	8100	32100	1002
INCORL0064	EAGLE CREEK RESERVOIR	39 49.5	C S R	75.0	0	0	
2	MARION - EAGLE CREEK	86 18.5	OP	75000	0	0	
	DEPT PUBLIC WORK INDPLS.	168	168.0	31.9	0	0	2010
INCORL0070	MISSISSINEWA LAKE	40 43.4	CR	140.0	0	0	
2	MIAMI - MISSISSINEWA	85 57.5	OP	570300	13226	29777	
	DAEN ORL	809	809.0	96.3	13226	29777	1001
INCORL0072	MONROE LAKE	39 0.3	C R	93.0	0	0	
2	MONROE - SALT CREEK	86 30.7	OP	702200	5241	10413	
	DAEN ORL	441	441.0	43.2	5241	10413	2003

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SITE ID NUMBER ACTV. INV.	PROJECT NAME / PRIMARY CO. -NAME OF STREAM / OWNER	LATITUDE (D M.M) / LONGITUDE (D M.M) / DR.AREA (SQ.MI)	PROJ.PURP. / STATUS / AVE. Q (CFS)	DAM HT (FT) / MX.STOR. (AC FT) / PWR. HD. (FT)	EXIST.CAP. (KW) / INC. CAP. (KW) / TOT. CAP. (KW)	EXIST.ENRG (MWH) / INC.ENERGY (MWH) / TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) / ERC NONECONOMIC (SEQUENCE RANK) / ERC COMPOSITE (SEQUENCE RANK)
INCORL0078	CECIL M HARDEN LAKE	39 43.0	C R	119.0	0	0	
2	PARKE - RACCOON CREEK	87 4.3	OP	132800	0	0	
	DAEN ORL	216	216.0	61.9	0	0	2010
INCORL0086	CAGLES MILL LAKE	39 29.2	CR	150.0	0	0	
2	PUTNAM - MILL CREEK	86 54.9	OP	344000	3597	8812	
	DAEN ORL	295	295.0	83.1	3597	8812	1001
INCORL0089	VERSAILLES LAKE	39 4.5	R S	52.0	0	0	
2	RIBLEY - LAUGHERY CREE	85 14.3	OP	2970	1700	3000	
	DEPT OF NAT RESOURCES	168	168.0	33.9	1700	3000	2005
INCORL0096	SALAMONIE LAKE	40 48.5	C R	133.0	0	0	
2	WABASH - SALAMONIE RIV	85 40.7	OP	459000	10528	20759	
	DAEN ORL	553	553.0	93.1	10528	20759	1001
INOORL0099	NORWAY DAM	40 46.8	HR	32.0	4000	24700	
2	WHITE - TIPPECANOE RI	86 45.6	OP	16400	0	0	
	NORTH IN PUB SERVICE CO	1732	1500.0	30.0	0	0	2005

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE (D M.M) LONGITUDE (D M.M) DR. AREA (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT (FT) MX.STOR. (AC FT) PWR. HD. (FT)	EXIST.CAP. (KW) INC. CAP. (KW) TOT. CAP. (KW)	EXIST.ENRG (MWH) INC.ENERGY (MWH) TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) ERC NONECONOMIC (SEQUENCE RANK) ERC COMPOSITE (SEQUENCE RANK)
KYAORL0101	KENTUCKY RIVER LOCK + DAM 05	38 3.1	N	31.2	0	0	
2	ANDERSON - KENTUCKY RIVE	84 49.7	OP	20	16200	18400	
	DAEN ORL	5225	7838.0	10.8	16200	18400	2003
KYAORL0103	OHIO RIVER LOCK + DAM 53	37 11.8	N	24.0	0	0	
2	BALLARD - OHIO RIVER	89 2.2	OP	16	70000	145000	
	DAEN ORL	203100	304700.0	0.7	70000	145000	1002
KYCORL0104	BARREN RIVER LAKE	36 53.8	CR	146.0	0	0	
2	BARREN - BARREN RIVER	86 7.5	OP	815200	13372	48369	
	DAEN ORL	940	1410.0	79.9	13372	48369	1001
KYCORL0105	CAVE RUN LAKE	38 7.1	CR	148.0	0	0	
2	BATH - LICKING RIVER	83 31.9	OP	972000	18266	43244	
	DAEN ORL	826	1239.0	85.2	18266	43244	1001
KYAORH0001	CAPTAIN ANTHONY MELDAHL L+D	38 47.5	NR	75.0	0	0	
2	BRACKEN - OHIO RIVER	84 10.2	OP	0	75000	394000	
	DAEN ORH	70808	91890.0	16.5	75000	394000	1002
KYCORL0108	ROUGH RIVER LAKE	37 37.1	CRS	130.0	0	0	
2	BRECKINRIDGE- ROUGH RIVER	86 30.0	OP	681000	14960	30354	
	DAEN ORL	454	681.0	87.4	14960	30354	1001
KY6ORL0109	ROCHESTER	37 12.6		100.0	0	0	
2	BUTLER - GREEN RIVER	86 54.0		3513000	179656	346400	
		6180	9270.0	61.9	179656	346400	2003
KYCORH0002	GRAYSON	38 15.1	CRO	120.0	0	0	
2	CARTER - LITTLE SANDY	82 59.1	OP	118990	3946	6255	
	DAEN ORH	196	248.0	58.9	3946	6255	1001

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SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE (D M.M) LONGITUDE (D M.M) DR.AREA (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT (FT) MX.STOR. (AC FT) PWR. HD. (FT)	EXIST.CAP. (KW) INC. CAP. (KW) TOT. CAP. (KW)	EXIST.ENRG (MWH) INC.ENERGY (MWH) TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) ERC NONECONOMIC (SEQUENCE RANK) ERC COMPOSITE (SEQUENCE RANK)
KYCORL0116	NOLIN LAKE	37 16.7	CR	166.0	0	0	
2	EDMONSON - NOLIN RIVER	86 14.6	OP	875000	18757	49159	
	DAEN ORL	703	1054.0	89.0	18757	49159	1001
KYAORL0118	KENTUCKY RIVER LOCK + DAM 11	37 47.1	N	34.0	0	0	
2	ESTILL - KENTUCKY RIVE	84 6.2	OP	23	6200	19600	
	DAEN ORL	3219	4829.0	15.1	6200	19600	2003
KYAORL0119	KENTUCKY RIVER LOCK + DAM 12	37 40.6	N	29.0	0	0	
2	ESTILL - KENTUCKY RIVE	83 56.8	OP	20	5500	16000	
	DAEN ORL	2916	4374.0	13.9	5500	16000	2003
KYCORH0003	DEWEY	37 44.2	CRO	118.0	0	0	
2	FLOYD - JOHNS CREEK	82 43.8	OP	93300	3824	5861	
	DAEN ORH	207	227.0	48.9	3824	5861	1001
KYAORL0120	KENTUCKY RIVER LOCK + DAM 04	38 12.6	N	30.0	0	0	
2	FRANKLIN - KENTUCKY RIVE	84 52.3	OP	50	5400	26400	
	DAEN ORL	5412	8118.0	10.2	5400	26400	1002
KYAORH0006	GREENUP L+D	38 38.8	NR	45.0	0	0	
2	GREENUP - OHIO RIVER	82 51.4	OP	0	70000	368000	
	DAEN ORH	62000	92050.0	19.2	70000	368000	1002
KY6ORH0007	KEHOE LAKE	38 29.0	CRO	120.0	0	0	
2	GREENUP - TYGARTS CREEK	83 1.9	OP	48100	3033	4523	
		127	158.0	58.9	3033	4523	2005
KYAORL0303	CANNELTON LOCKS AND DAM	37 51.9	N	40.0	0	0	
2	HANCOCK - OHIO RIVER	86 42.3	OP	10	71000	340000	
	DAEN ORL	97690	97690.0	15.4	71000	340000	1002

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SITE ID / NUMBER / ACTV. INV.	PROJECT NAME / PRIMARY CO. -NAME OF STREAM / OWNER		LATITUDE (D M.M) / LONGITUDE (D M.M) / DR.AREA (SQ.MI)	PROJ.PURP. / STATUS / AVE. Q (CFS)	DAM HT (FT) / MX.STOR. (AC FT) / PWR. HD. (FT)	EXIST.CAP. (KW) / INC. CAP. (KW) / TOT. CAP. (KW)	EXIST.ENRG (MWH) / INC.ENERGY (MWH) / TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) / ERC NONECONOMIC (SEQUENCE RANK) / ERC COMPOSITE (SEQUENCE RANK)
KYAORL0125	GREEN R L + D #1		37 51.5	N	41.7	0	0	
2	HENDERSON	GREEN RIVER	87 24.5	UP	16	4700	13500	
	DAEN ORL		9181	13770.0	6.5	4700	13500	1002
KYAORL0126	NEWBURG LOCK + DAM		37 54.6	N	48.0	0	0	
2	HENDERSON	OHIO RIVER	87 21.7	UP	16	57400	214000	
	DAEN ORL		97690	97690.0	8.8	57400	214000	1002
KYAORL0128	KENTUCKY RIVER LOCK AND DAM		38 26.2	N	29	0	0	
2	HENRY	KENTUCKY RIVE	84 57.6	UP	19	3300	10500	
	DAEN ORL		6180	9270.0	8.0	3300	10500	1002
KYAORL0129	KENTUCKY RIVER LOCK + DAM 03		38 25.0	N	28.4	0	0	
2	HENRY	KENTUCKY RIVE	84 52.8	UP	18	6000	28700	
	DAEN ORL		5983	8975.0	14.4	6000	28700	1002
KYAORL0132	KENTUCKY RIVER LOCK + DAM 08		37 44.7	N	34	0	0	
2	JESSAMINE	KENTUCKY RIVE	84 35.1	UP	25	7386	29801	
	DAEN ORL		4414	6621.0	16.9	7386	29801	2003
KYAORL0133	KENTUCKY RIVER LOCK + DAM 09		37 50.5	N	34	0	0	
2	JESSAMINE	KENTUCKY RIVE	84 26.4	UP	23	3843	16586	
	DAEN ORL		4101	6152.0	14.9	3843	16586	2003
KY6ORH0008	PAINTSVILLE		37 50.1	CRO	160.0	0	0	
2	JOHNSON	PAINT CREEK	82 52.1	UC	73500	0	0	
	DAEN ORH		93	112.0	106.8	0	0	2010
KYCORL0134	CARR FORK LAKE		37 13.4	CR	130.0	0	0	
2	KNOTT	CARR FORK	83 3.4	UP	47700	0	0	
	DAEN ORL		58	87.0	73.9	0	0	2010

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KYCORN0033	WOOD CK LAKE	37 12.8	SR	163.0	0	0	
2	LAUREL - WOOD CK	84 11.8	OP	44500	0	0	
	COMMONWEALTH OF KENTUCKY	22	44.5	154.8	0	0	2010
KY60RH0009	YATESVILLE	38 3.5	CRO	105.0	0	0	
2	LAWRENCE - BLAINE CREEK	82 51.9		99800	2146	4427	
	DAEN ORH	208	234.0	44.9	2146	4427	2005
KYAORL0139	KENTUCKY RIVER LOCK + DAM 13	37 36.1	N	30	0	0	
2	LEE - KENTUCKY RIVE	83 50.0	OP	23	6100	18800	
	DAEN ORL	2784	4176.0	15.5	6100	18800	2003
KYAORL0140	KENTUCKY RIVER LOCK + DAM 14	37 33.1	N	30	0	0	
2	LEE - KENTUCKY RIVE	83 46.1	OP	23	6049	21052	
	DAEN ORL	2657	3986.0	16.2	6049	21052	2003
KYAORL0146	SMITHLAND L + D	37 9.2	N	59	0	0	
2	LIVINGSTON - OHIO RIVER	88 24.8	OP	50	120000	571000	
	DAEN ORL	143900	220000.0	11.1	120000	571000	1002
KYAORL0152	KENTUCKY RIVER LOCK + DAM 10	37 53.6	N	34	0	0	
2	MADISON - KENTUCKY RIVE	84 15.7	OP	23	4800	20900	
	DAEN ORL	3955	5933.0	15.8	4800	20900	2003
KYAORL0154	OHIO RIVER LOCK + DAM 52	37 7.3	N	32.2	0	0	
2	MCCRACKEN - OHIO RIVER	88 39.3	OP	16	69100	142600	
	DAEN ORL	202830	202830.0	3.2	69100	142600	1002
KYAORL0155	GREEN RIVER LOCK + DAM 02	37 31.9	N	41.8	0	0	
2	MCLEAN - GREEN RIVER	87 15.8	OP	19	5500	19800	
	DAEN ORL	7564	11400.0	9.5	5500	19800	1002
KY60RL0159	CAMPGROUND LAKE	37 49.5	CSRO	150.0	0	0	
2	NELSON - BEECH FK SALT	85 17.4	DM	360740	15000	35900	
		438	659.0	112.2	15000	35900	2005

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KYAORL0161	GREEN RIVER LOCK AND DAM 03	37 12.8	N	32.3	0	0	
2	OHIO - GREEN RIVER	86 54.0	OP	23	9000	27700	
	DAEN ORL	6141	9212.0	11.6	9000	27700	1002
KY6ORL0163	BOONEVILLE LAKE	37 28.6		202.0	0	0	
2	OWSLEY - SO FK KENTUCK	83 40.2		630000	17085	42061	
		687	1030.0	99.9	17085	42061	2005
KYCORL0164	FALMOUTH LAKE	38 35.7		157.0	0	0	
2	PENDLETON - LICKING RIVER	84 15.7		898300	40000	137000	
		2331	3500.0	88.9	40000	137000	2005
KYCORL0167	BUCKHORN LAKE	37 20.3	CR	160.0	0	0	
2	PERRY - MIDDLEFORK KE	83 28.3	OP	310000	7784	19186	
	DAEN ORL	408	612.0	76.6	7784	19186	1001
KYCORH0010	FISHTRAP	37 25.8	CRO	195.0	0	0	
2	PIKE - LEVISA FORK	82 24.9	OP	164360	3500	12600	
	DAEN ORH	395	465.0	81.9	3500	12600	1001
KYCORL0174	TAYLORSVILLE LAKE	38 0.0		163.0	0	0	
2	SPENCER - SALT RIVER	85 18.1		480000	16884	23306	
	DAEN ORL	353	530.0	102.6	16884	23306	2003
KYCORL0175	GREEN RIVER LAKE	37 20.3	CR	143.0	0	0	
2	TAYLOR - GREEN RIVER	85 15.2	OP	1164000	20613	47662	
	DAEN ORL 4741	682	1023.0	98.9	20613	47662	1001
KYAORL0176	UNIONTOWN LOCK + DAM	37 46.1	N	30	0	0	
2	UNION - OHIO RIVER	87 57.5	OP	30	65000	189000	
	DAEN ORL	108000	108000.0	7.8	65000	189000	1002
KYAORL0178	BARREN R L & D 1	37 5.1	N	36.5	0	0	
2	WARREN - BARREN RIVER	86 30.2	OP	20	3800	12500	
	DAEN ORL	1966	2949.0	12.7	3800	12500	1002

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KYAORL0180	KENTUCKY RIVER LOCK + DAM 06	37 55.6	N	30.5	0	0	
2	WOODFORD - KENTUCKY RIVE	84 49.2	OP	19	4503	20794	
	DAEN ORL	5102	7653.0	12.9	4503	20794	2003

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE (D M.M) LONGITUDE (D M.M) DR.AREA (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT (FT) MX.STOR. (AC FT) PWR. HD. (FT)	EXIST.CAP. (KW) INC. CAP. (KW) TOT. CAP. (KW)	EXIST.ENRG (MWH) INC.ENERGY (MWH) TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) ERC NONECONOMIC (SEQUENCE RANK) ERC COMPOSITE (SEQUENCE RANK)
MDCNAB0012	BLOOMINGTON	39 24.0	CSOR	294.0	0	0	
2	GARRETT - N BR POTOMAC	78 52.5	UC	141700	9643	37367	
	DAENNAB	287	437.0	245.9	9643	37367	1001
MDCNAB0011	SAVAGE RIVER DAM	39 29.6	CSO	184.0	0	0	
2	GARRETT - SAVAGE RIVER	79 7.5	OP	28700	0	0	
	UPPERPOTOMACR COMM.	105	165.0	129.6	0	0	2010
MDGNAB9999	POTOMAC DAM NO 5	39 35.9	H	20.0	1120	7600	
2	WASHINGTON - POTOMAC	78 0.0	OP	4000	2903	10900	
	U.S. DEPT OF INTERIOR	4940	4940.0	12.9	4023	18500	2004
MDGNAB0022	POTOMAC RIVER DAM 4	39 29.9	HRS	20.0	1000	7177	
2	WASHINGTON - POTOMAC RIVER	77 50.0	OP	7000	4800	24600	
	U.S. DEPT OF INTERIOR	5900	5900.0	15.5	5800	31777	2004

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MIINCE0006	ALCONA	44 33.7	H		54.0	8206	25463	
2	ALCONA - AUSABLE R	83 47.7	OP		6000	2800	16200	
	CONSUMERS POWER CO	1469		1327.8	49.3	11006	41663	1002
MIINCE0013	FOUR MILE DAM	45 5.7	HYDRUEL		35.0	0	0	
2	ALPENA - THUNDER BAY R	83 30.1	OP		1200	0	0	
	ALPENA POWER CO.	1265		1030.9	0	0	0	2010
MIINCE0026	BERRIEN SPRINGS	41 56.6	H		24.0	7200	40879	
2	BERRIEN - ST JOSEPH	86 19.7	OP		7000	7200	13500	
	IND + MICH ELECTRIC CO	4081		3542.4	20.9	14400	54379	1002
MIGNCE0023	BUCHANAN	41 50.3	H		28.0	4104	24374	
2	BERRIEN - ST JOSEPH RIV	86 21.1	OP		2400	0	0	
	IND + MICH ELECTRIC CO	4037		3500.9	13.0	0	0	2010
MIINCE0036	KLEBER DAM	45 23.4	H		45.0	1200	10271	
2	CHEBOYGAN - UPPER BLACK	84 19.7	OP		5650	3700	14400	
	NORTHERN MICH ELECTRIC C	1300		1131.8	26.5	4900	24671	1002
MIHNCE0143	EDISON SAULT	46 49.9	H		25.0	30000	297200	
2	CHIPPEWA - ST MARYS RIVE	84 30.0	OP		91792000	* SEE NOTE	0	
	EDISON SAULT ELECTRIC CO	80900		29000.0	20.9		0	2005
MIGNCE0144	ST MARYS FALLS	46 49.9	H		36.0	18400	161150	
2	CHIPPEWA - ST MARYS RIVE	84 30.0	OP		17952000	* SEE NOTE	0	
	DAEN NCE	80000		13000.0	20.9		0	2005
MIINCE9023	EDENVILLE	43 48.9	H		54.0	4800	15905	
2	GLADWIN - TITTAHAWASSEE	84 23.2	OP		66200	0	0	
	WOLVERINE POWER CO	1050		697.3	45.0	0	0	2010
MIINCE0054	SECORD DAM	44 2.5	H		50.0	1200	5065	
2	GLADWIN - TITTIBAWASSEE	84 20.5	OP		51000	0	0	
	WOLVERINE POWER CO	210		204.6	43.7	0	0	2010

* The incremental potential of these sites has not been established since flows through the St. Mary's River are regulated by international agreement. A separate study is underway to determine whether it is feasible to adjust flows and diversions to provide increased hydro capacity at one or both sites.

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV. INV.	PROJECT NAME / PRIMARY CO. -NAME OF STREAM / OWNER	LATITUDE (D M.M) / LONGITUDE (D M.M) / DR.AREA (SQ.MI)	PROJ.PURP. / STATUS / AVE. Q (CFS)	DAM HT (FT) / MX.STOR. (AC FT) / PWR. HD. (FT)	EXIST.CAP. (KW) / INC. CAP. (KW) / TOT. CAP. (KW)	EXIST.ENRG (MWH) / INC.ENERGY (MWH) / TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) / ERC NONECONOMIC (SEQUENCE RANK) / ERC COMPOSITE (SEQUENCE RANK)
MIINCE9022	SMALLWOOD DAM	43 56.5	HYDROEL	36.0	1200	0	
2	GLADWIN - TITTIBAWASSEE	84 19.9	OP	9000	0	0	
	WOLVERINE POWER CO.	342	231.0	0	0	0	2010
MIINCE0064	WEBBER	42 57.4	H	33.0	3250	10181	
2	IONIA - GRAND	84 54.1	OP	8900	2900	10600	
	CONSUMERS PWR CO	1751	1206.2	30.7	6150	20781	2004
MIINCE0068	FOOTE	44 26.0	H	55.0	9000	29434	
2	IOSCO - AU SABLE R	83 26.4	OP	43500	0	0	
	CONSUMERS PWR CO	1644	1490.4	37.0	0	0	2010
MIINCE0069	LOUD	44 29.2	H	55.0	4000	18385	
2	IOSCO - AU SABLE	83 43.1	OP	13800	0	0	
	CONSUMERS POWER CO	1602	1452.4	24.6	0	0	2010
MIONCE9019	LOWELL DAM NO. 1	42 59.7	R	44.0	0	0	
2	KENT - FLAT RIVER	85 21.6	OP	3300	4495	10982	
	CASCADE TWP.	545	451.7	38.6	4495	10982	2004
MIINCE0108	ROGERS	43 36.7	H	56.0	6750	26862	
2	MECOSTA - MUSKEGON	85 28.7	OP	12810	0	0	
	CONSUMERS PWR CO	1746	1460.6	35.7	0	0	2010
MIINCE9024	SANFORD	43 40.6	H	36.0	3300	10198	
2	MIDLAND - TITTABAWASSEE	84 22.9	OP	34500	0	0	
	WOLVERINE POWER CO	1090	723.8	27.0	0	0	2010
MIINCE0120	CROTON	43 25.2	H	60.0	9000	37482	
2	NEWAYGO - MUSKEGON	85 48.1	OP	35900	1500	2500	
	CONSUMERS PWR CO	2224	1877.1	34.4	10500	39982	1002
MIINCE0121	HARDY	43 29.2	H	100.0	30000	86536	
2	NEWAYGO - MUSKEGON	85 37.8	OP	183400	4500	8700	
	CONSUMERS PWR CO	1851	1562.3	95.2	34500	95236	1002

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE (D M.M) LONGITUDE (D M.M) DR.AREA (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT (FT) MX.STOR. (AC FT) PWR. HD. (FT)	EXIST.CAP. (KW) INC. CAP. (KW) TOT. CAP. (KW)	EXIST.ENRG (MWH) INC.ENERGY (MWH) TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) ERC NONECONOMIC (SEQUENCE RANK) ERC COMPOSITE (SEQUENCE RANK)
MIONCE9025 2	FRENCH LANDING WAYNE - HURON VAN BUREN TWP	42 12.8 83 26.8 825	R OP 496.7	38.0 26400 29.3	0 5115 5115	0 9052 9052	 1002

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID	PROJECT NAME	LATITUDE	PROJ.PURP.	DAM HT	EXIST.CAP.	EXIST.ENRG	ERC ECONOMIC
NUMBER	PRIMARY CO. -NAME OF STREAM	LONGITUDE	STATUS	MX.STOR.	INC. CAP.	INC.ENERGY	ERC NONECONOMIC
ACTV. INV.	OWNER	DR.AREA	AVE. Q	PWR. HD.	TOT. CAP.	TOT.ENERGY	ERC COMPOSITE
		(D M.M)		(FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(D M.M)		(AC FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(SQ.MI)	(CFS)	(FT)	(KW)	(MWH)	(SEQUENCE RANK)
OHCORH0019	PLEASANT HILL	40 36.1	CRO	113.0	0	0	
2	ASHLAND - CLEAR FORK	82 19.6	OP	87700	3179	6191	
	DAEN ORH	197	194.0	53.9	3179	6191	1001
OHCORL0028	CLARENCE J. BROWN RESERVOIR	40 0.0	CR	72.0	0	0	
2	CLARK - BUCK CREEK	83 25.2	OP	63700	0	0	
	DAEN ORL	82	82.0	43.9	0	0	2010
OHCORL0186	EAST FORK LAKE	38 57.2	CR	200.0	0	0	
2	CLEARMONT - EAST FORK OF	84 5.1	OP	394000	15000	25000	
	DAEN ORL	342	342.0	152.8	15000	25000	1001
OHONCB0192	DEFIANCE POWER DAM	41 14.2	R	40.0	0	0	
2	DEFIANCE - AUGLAIZE RIVE	84 24.0	IS	12000	4103	12545	
	TOLEDO EDISON POWER CO	2329	1690.0	23.9	4103	12545	2004
OHCORH0023	ALUM CREEK	40 10.6	CR	93.0	0	0	
2	DELAWARE - ALUM CREEK	82 57.3	OP	134800	0	0	
	DAEN ORH	123	120.0	65.9	0	0	2010
OHCORH0025	DELAWARE	40 21.5	CRSO	92.0	0	0	
2	DELAWARE - OLENTANGY RIV	83 4.2	OP	132000	0	0	
	DAEN ORH	381	347.0	33.9	0	0	2010
OHCORH0026	OSHAUGNESSY	40 5.9	SR	70.0	0	0	
2	DELAWARE - SCIOTO	83 7.5	OP	15838	5261	17127	
	COLUMBUS	979	787.0	74.9	5261	17127	1002
OHCORH0028	HOOVER	40 5.9	SR	90.0	0	0	
2	FRANKLIN - BIG WALNUT CR	82 52.8	OP	90000	0	0	
	COLUMBUS	190	184.0	64.9	0	0	2010
OHCORH0029	J GRIGGS	40 0.0	SR	30.0	0	0	
2	FRANKLIN - SCIOTO	83 5.5	OP	15300	4181	8812	
	COLUMBUS	1044	839.0	24.9	4181	8812	1002

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE LONGITUDE DR.AREA (D M.M) (D M.M) (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT MX.STOR. PWR. HD. (FT) (AC FT) (FT)	EXIST.CAP. INC. CAP. TOT. CAP. (KW) (KW) (KW)	EXIST.ENRG INC.ENERGY TOT.ENERGY (MWH) (MWH) (MWH)	ERC ECONOMIC ERC NONECONOMIC ERC COMPOSITE (SEQUENCE RANK) (SEQUENCE RANK) (SEQUENCE RANK)
OHCORH0031	SENECAVILLE	39 55.6	CRO	45.0	0	0	
2	GUERNSEY - SENECA FORK	81 26.7	OP	88500	0	0	
	DAEN ORH	118	129.0	27.9	0	0	2010
OHCORH0032	WILLS CREEK	40 5.9	CRO	87.0	0	0	
2	GUERNSEY - WILLS CREEK	81 50.8	OP	196000	0	0	
	DAEN ORH	842	905.0	20.9	0	0	2010
OHCORL0029	WEST FORK OF MILL CREEK LAKE	39 10.8	CR	100.0	0	0	
2	HAMILTON - W FORK OF MIL	84 18.0	OP	11380	0	0	
	DAEN ORL	30	30.0	47.9	0	0	2010
OHCORH0033	CLENDENING	40 16.1	CRO	64.0	0	0	
2	HARRISON - BRUSHY FORK	81 16.5	OP	54000	0	0	
	DAEN ORH	69	140.0	38.9	0	0	2010
OHCORH0034	PIEDMONT	40 11.4	CRO	56.0	0	0	
2	HARRISON - STILLWATER CR	81 12.7	OP	66700	0	0	
	DAEN ORH	86	133.0	36.9	0	0	2010
OHCORH0036	PAINT CREEK	39 15.1	C	118.0	0	0	
2	HIGHLAND - PAINT CREEK	83 20.9	OP	145000	8036	14353	
	DAEN ORH	573	600.0	48.9	8036	14353	1001
OHANCB4321	EAST FALLS	41 22.2	O	10.0	0	0	
2	LORAIN - BLACK RIVER	82 06.4	OP	50	17405	50630	
	DR. E. MULLER	217	152.0	49.0	17405	50630	2004
OHCORP0028	LAKE MILTON	41 5.9	RCS	64.0	0	0	
2	MAHONING - MAHONING RIVE	80 58.7	OP	27120	2569	5608	
	CITY OF YOUNGSTOWN	273	238.0	37.9	2569	5608	1002

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OHCORP7799	OHIO WATER COMPANY		S	0	0	0	
2	MAHONING - MAHONING RIVE		OP	0	0	0	
	OHIO WATER CO.		0	0	0	0	2010
OHAORH0043	LOCK + DAM NO.6	39 32.7	R	15.0	0	0	
2	MORGAN - MUSKINGHAM RI	81 47.3	OP	0	2000	12000	
	OHIO	7611	7509.0	8.6	2000	12000	1002
OHAORH0044	LOCK + DAM NO.7	39 38.6	R	28.0	0	0	
2	MORGAN - MUSKINGHAM RI	81 50.9	OP	0	1400	9500	
	OHIO	7411	7334.0	6.8	1400	9500	1002
OHAORH0045	LOCK + DAM NO.8	39 44.0	R	22.0	0	0	
2	MORGAN - MUSKINGHAM RI	81 54.4	OP	0	2100	11000	
	OHIO	7248	7151.0	8.0	2100	11000	1002
OHCORH0046	DILLON	39 59.4	CRO	118.0	0	0	
2	MUSKINGUM - LICKING RIVER	82 4.7	OP	274000	6526	11998	
	DAEN ORH	742	786.0	30.9	6526	11998	1001
OHAORH0048	LOCK + DAM NO.9	39 52.2	R	12.0	0	0	
2	MUSKINGUM - MUSKINGHAM RI	81 54.5	OP	0	3605	20495	
	OHIO	7019	6925.0	8.8	3605	20495	1002

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OHAORH0049	LOCK + DAM NO.10	39 56.4	R	37.0	0	0	
2	MUSKINGUM - MUSKINGHAM RI	81 0.7	OP	0	6644	34781	
	OHIO	6840	6749.0	13.9	6644	34781	1002
OHCORH0050	DEER CREEK	39 37.3	CRO	93.0	0	0	
2	PICKAWAY - DEER CREEK	83 12.9	OP	102540	0	0	
	DAEN ORH	277	295.0	38.9	0	0	2010
OHCORP0034	BERLIN LAKE	41 2.7	CRSO	96.0	0	0	
2	PORTAGE - MAHONING RIVE	81 0.2	OP	91200	3000	7400	
	DAEN ORP	249	229.0	72.6	3000	7400	1001
OHANCB4322	GORGE DAM	41 07.8	H	62.0	0	0	
2	SUMMIT - CUYAHOGA RIVE	81 29.8	IS	500	14455	31297	
	OHIO EDISON	340	469.2	114.8	14455	31297	2004
OHCORP0033	MICHAEL J KIRWAN DAM AND RES	41 19.3	CROS	83.0	0	0	
2	PORTAGE - WEST BRANCH O	81 4.7	OP	78700	0	0	
	DAEN ORP	81	104.0	58.0	0	0	2010
OHANCB0195	FREMONT LOW HEAD DAM	41 19.5	R	25.0	0	0	
2	SANDUSKY - SANDUSKY RIVE	83 8.2	IS	817	4706	9853	
	CITY OF FREMONT	1251	940.0	23.9	4706	9853	2004
OHCORP0037	MOSQUITO CREEK DAM	41 17.9	CRSO	47.0	0	0	
2	TRUMBULL - MOSQUITO CREE	80 45.4	OP	104100	0	0	
	DAEN ORP	97	86.0	32.3	0	0	2010
OHCORH0052	ATWOOD LAKE	40 31.5	CRO	65.0	0	0	
2	TUSCARAWAS - INDIAN FORK	81 17.0	OP	49700	0	0	
	DAEN ORH	70	72.0	40.9	0	0	2010

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OHCORH0053	BEACH CITY	40 38.2	CRO	64.0	0	0	
2	TUSCARAWAS - SUGAR CREEK	81 33.4	OP	71700	0	0	
	DAEN ORH	300	140.0	16.9	0	0	2010
OHCORH0054	DOVER	40 33.3	C	83.0	0	0	
2	TUSCARAWAS - TUSCARAWAS RI	81 24.8	OP	203000	0	0	
	DAEN ORH	1379	1387.0	8.9	0	0	2010
OHCORL0202	CAESAR CREEK LAKE	39 27.4	CR	165.0	0	0	
2	WARREN - CAESAR CREEK	83 58.4	OP	370000	6142	15100	
	DAEN ORL	237	237.0	135.9	6142	15100	1001
OHAORH0056	LOCK + DAM NO.2	39 28.2	R	19.0	0	0	
2	WASHINGTON - MUSKINGHAM RI	81 29.5	OP	0	2000	11000	
	OHIO	8018	7911.0	7.4	2000	11000	1002
OHAORH0057	LOCK + DAM NO.3	39 31.7	R	20.0	0	0	
2	WASHINGTON - MUSKINGHAM RI	81 31.0	OP	0	6746	32210	
	OHIO	7985	7878.0	12.4	6746	32210	1002
OHAORH0058	LOCK + DAM NO.4	39 33.1	R	16.0	0	0	
2	WASHINGTON - MUSKINGHAM RI	81 38.7	OP	0	4000	9000	
	OHIO	7940	7834.0	5.8	4000	9000	1002
OHAORH0059	LOCK + DAM NO.5	39 32.1	R	20.0	0	0	
2	WASHINGTON - MUSKINGHAM RI	81 43.3	OP	0	2000	11000	
	OHIO	7744	7641.0	7.5	2000	11000	1002

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PAAORP0042	ALLEGHENY RIVER L/D 02	40 29.2	N	58.0	0	0	
2	ALLEGHENY - ALLEGHENY RIV	79 54.8	OP	0	10683	66213	
	DAEN ORP	11636	19540.0	10.9	10683	66213	1002
PAAORP0043	ALLEGHENY R L/D 03	40 32.3	N	36.0	0	0	
2	ALLEGHENY - ALLEGHENY RIV	79 48.9	OP	0	16301	93134	
	DAEN ORP	11537	19400.0	13.4	16301	93134	1002
PAAORP0044	ALLEGHENY R L/D 04	40 36.9	N	10.5	0	0	
2	ALLEGHENY - ALLEGHENY RIV	79 43.0	OP	0	18169	89245	
	DAEN ORP	11419	19240.0	10.4	18169	89245	1002
PAAORP0048	DASHIELDS L/D	40 32.9	N	39.0	0	0	
2	ALLEGHENY - OHIO RIVER	80 12.5	OP	0	22000	120000	
	DAEN ORP	19522	32370.0	9.6	22000	120000	1002
PAAORP0047	EMSWORTH L/D	40 30.3	N	25.0	0	0	
2	ALLEGHENY - OHIO RIVER	80 5.2	OP	0	38000	220000	
	DAEN ORP	19428	32290.0	17.2	38000	220000	1002
PAAORP0045	MONONGAHELA RIVER L/D 2	40 23.4	N	33.0	0	0	
2	ALLEGHENY - MONONGAHELA R	79 51.4	OP	0	6747	38827	
	DAEN ORP	7342	12300.0	8.6	6747	38827	1002
PAAORP0046	MONONGAHELA RIVER L/D 3	40 15.9	N	16.0	0	0	
2	ALLEGHENY - MONONGAHELA R	79 53.9	OP	0	4736	25660	
	DAEN ORP	5340	9100.0	8.1	4736	25660	1002
PAAORP0052	ALLEGHENY R L/D 05	40 41.0	N	16.0	0	0	
2	ARMSTRONG - ALLEGHENY RIV	79 39.9	OP	0	17144	82487	
	DAEN ORP	9351	16130.0	11.7	17144	82487	1002
PAAORP0053	ALLEGHENY R L/D 06	40 43.0	N	12.1	0	0	
2	ARMSTRONG - ALLEGHENY RIV	79 34.7	OP	0	17387	84341	
	DAEN ORP	9332	16100.0	12.1	17387	84341	1002

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PAAORP0054	ALLEGHENY R L/D 07	40 49.1	N	19.0	0	0	
2	ARMSTRONG - ALLEGHENY RIV	79 31.6	OP	0	18916	89508	
	DAEN ORP	8982	15570.0	13.0	18916	89508	1002
PAAORP0055	ALLEGHENY R L/D 08	40 53.6	N	60.0	0	0	
2	ARMSTRONG - ALLEGHENY RIV	79 28.7	OP	0	17037	96277	
	DAEN ORP	8844	15280.0	17.8	17037	96277	1002
PAAORP0056	ALLEGHENY R L/D 09	40 57.2	N	22.0	0	0	
2	ARMSTRONG - ALLEGHENY RIV	79 32.8	OP	13500	15828	89333	
	DAEN ORP	8401	14480.0	19.4	15828	89333	1002
PACORP0050	CROOKED CREEK DAM	40 42.8	CR	143.0	0	0	
2	ARMSTRONG - CROOKED CREEK	79 30.6	OP	93900	15369	27518	
	DAEN ORP	277	421.0	116.8	15369	27518	1001
PACORP0051	MAHONING CREEK DAM	40 55.2	CR	162.0	0	0	
2	ARMSTRONG - MAHONING CREE	79 16.6	OP	74200	7000	16000	
	DAEN ORP	340	589.0	65.9	7000	16000	1001
PAAORP0059	MONTGOMERY L/D	40 39.0	N	62.0	0	0	
2	BEAVER - OHIO RIVER	80 23.1	OP	0	38000	197000	
	DAEN ORP	22969	36280.0	15.1	38000	197000	1002
PACORP0066	MORAINE STATE PARK DAM	40 57.8	R	55.0	0	0	
2	BUTLER - MUDDY CREEK	80 7.1	OP	38000	0	0	
	DEPT OF FORESTS + WATER	53	74.0	42.9	0	0	2010
PACNAB0125	GEORGE B STEVENSON	41 24.4	CR	166.0	0	0	
2	CAMERON - FIRST FORK	78 1.1	OP	128000	2045	5745	
	PA DER	243	370.0	29.7	2045	5745	2005
PACNAB0053	FOSTER JOSEPH SAYER	41 2.7	CR	100.0	0	0	
2	CENTRE - BALD EAGLE	77 36.6	OP	186000	3510	11618	
	DAENNAB	339	432.0	44.3	3510	11618	1001

EXHIBIT 1: INVENTORY, E C A R REGIONAL PLAN

SITE ID	PROJECT NAME	LATITUDE	PROJ.PURP.	DAM HT	EXIST.CAP.	EXIST.ENRG	ERC ECONOMIC
NUMBER	PRIMARY CO. -NAME OF STREAM	LONGITUDE	STATUS	MX.STOR.	INC. CAP.	INC.ENERGY	ERC NONECONOMIC
ACTV. INV.	OWNER	DR.AREA	AVE. Q	PWR. HD.	TOT. CAP.	TOT.ENERGY	ERC COMPOSITE
		(D M.M)		(FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(D M.M)		(AC FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(SQ.MI)	(CFS)	(FT)	(KW)	(MWH)	(SEQUENCE RANK)
PA6ORP0074	ST PETERSBURG	41 9.0	H	291.5	0	0	
2	CLARION - CLARION RIVER	79 39.0	IS	981300	243406	332442	
		1245	2194.7	244.7	243406	332442	2005
PACORP0081	EAST BRANCH DAM-CLARION RIVE	41 33.5	CRO	184.0	0	0	
2	ELK - CLARION RIVER	78 35.8	OP	84300	3008	11928	
	DAEN ORP	72	133.0	161.8	3008	11928	1001
PACORP0090	INDIAN CREEK DAM	39 58.8	S	34.7	0	0	
2	FAYETTE - INDIAN CREEK	79 27.2	OP	693	1800	4000	
	MUNICIPAL AUTH WESTM COUNTY	110	247.7	28.7	1800	4000	2003
PACORP0088	MAXWELL L/D	40 0.1	N	56.0	0	0	
2	FAYETTE - MONONGAHELA R	79 56.4	OP	0	16060	71607	
	DAEN ORP	4961	8700.0	19.4	16060	71607	1002
PAAORP0089	POINT MARION L/D	39 43.6	N	52.0	0	0	
2	FAYETTE - MONONGAHELA R	79 54.7	OP	0	11949	47812	
	DAEN ORP	2715	4580.0	19.7	11949	47812	1002
PA7ORP0083	VICTORIA	39 57.0	H	33.0	0	0	
2	FAYETTE - YOUGHIOGHENY	79 26.9	IS	2100	84658	215899	
		1055	1921.4	175.8	84658	215899	2005
PACORP0087	YOUGHIOGHENY RIVER DAM	39 47.9	CRO	184.0	0	0	
2	FAYETTE - YOUGHIOGHENY	79 22.1	OP	254000	15000	45000	
	DAEN ORP	434	859.0	122.4	15000	45000	2003
PAAORP0095	MONONGAHELA RIVER L/D 7	39 47.1	N	28.0	0	0	
2	GREENE - MONONGAHELA R	79 55.1	OP	0	14859	58885	
	DAEN ORP	4383	8090.0	14.9	14859	58885	1002
PACORP0111	SHENANGO RIVER DAM	41 15.9	CRO	67.6	0	0	
2	MERCER - SHENANGO RIVE	80 27.7	OP	156700	3000	10100	
	DAEN ORP	589	686.0	28.5	3000	10100	1001

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE (D M.M) LONGITUDE (D M.M) DR.AREA (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT (FT) MX.STOR. (AC FT) PWR. HD. (FT)	EXIST.CAP. (KW) INC. CAP. (KW) TOT. CAP. (KW)	EXIST.ENRG (MWH) INC.ENERGY (MWH) TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) ERC NONECONOMIC (SEQUENCE RANK) ERC COMPOSITE (SEQUENCE RANK)
PACORP0146	BEAVER RUN DAM	40 30.7	S	92.0	0	0	
2	WESTMORELAND- BEAVER RUN	79 33.2	OP	27540	0	0	
	WESTMORELAND MUN AUTH	43	61.0	66.9	0	0	2010
PACORP0139	LOYALHANNA DAM	40 27.4	CR	114.0	0	0	
2	WESTMORELAND- LOYALHANNA CR	79 27.1	OP	95300	14504	29864	
	DAEN ORP	290	480.0	105.8	14504	29864	1001
PAAORP0140	MONONGAHELA RIVER L/D 4	40 8.8	N	60.0	0	0	
2	WESTMORELAND- MONONGAHELA R	79 53.9	OP	0	13856	62912	
	DAEN ORP	5214	8980.0	16.5	13856	62912	1002

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID	PROJECT NAME	LATITUDE (D M.M)	PROJ.PURP.	DAM HT (FT)	EXIST.CAP. (KW)	EXIST.ENRG (MWH)	ERC ECONOMIC (SEQUENCE RANK)
NUMBER	PRIMARY CO. -NAME OF STREAM	LONGITUDE (D M.M)	STATUS	MX.STOR. (AC FT)	INC. CAP. (KW)	INC.ENERGY (MWH)	ERC NONECONOMIC (SEQUENCE RANK)
ACTV. INV.	OWNER	DR.AREA (SQ.MI)	AVE. Q (CFS)	PWR. HD. (FT)	TOT. CAP. (KW)	TOT.ENERGY (MWH)	ERC COMPOSITE (SEQUENCE RANK)
VAINA00026	REUSENS	37 27.8	H	39.0	12500	52958	
2	AMHERST - JAMES RIVER	79 11.1	OP	5000	15635	13149	
	APP POW	3264	3555.0	32.0	28135	66108	1001
VAANA00032	HOLCOMBS ROCK	37 30.5	H	20.0	1875	13794	
2	BEDFORD - JAMES RIVER	79 15.8	OP	0	4295	13477	
	OWENILL	3250	3550.0	17.0	6170	27271	1001
VAGNA00033	SNOWDEN	37 34.5	H	15.0	1300	10432	
2	BEDFORD - JAMES RIVER	79 22.5	OP	0	4985	17036	
	BEDFORD	3070	3344.0	18.0	6285	27468	1002
VA6NA00045	JOSHUA FALLS	37 25.0	H	54.0	0	0	
2	CAMPBELL - JAMES RIVER	79 3.5	IS	9200	38073	92586	
		3420	3877.0	42.7	38073	92586	2005
VAJNA00053	MEADOW CREEK	37 29.0	H	10.0	300	2020	
2	CRAIG - MEADOW CREEK	80 7.5	OP	0	1500	3200	
	LR BOT	14	16.0	670.0	1800	5220	1001
VACORH0065	FLANNAGAN	37 14.0	CORS	250.0	0	0	
2	DICKENSON - POUND RIVER	82 20.6	OP	145700	15004	25666	
	DAEN ORH	221	273.0	180.8	15004	25666	1001
VA6ORH0066	HAYSI RESERVOIR	37 15.9	C	165.0	0	0	
2	DICKENSON - RUSSEL FORK	82 26.9		82400	3172	5768	
	DAEN ORH	155	178.0	57.9	3172	5768	2005
VA6SAW0105	RIDGEWAY	36 33.9	HSR	110.0	0	0	
2	HENRY - SMITH RIVER	79 43.9	FP	144000	24703	39917	
	CITY OF MARTINSVILLE	529	627.0	108.9	24703	39917	1001
VAGNA00090	LYNCHBURG WATER WORKS DAM	37 25.4	H	20.0	0	0	
2	LYNCHBURG - JAMES RIVER	79 8.5	OP	1800	4013	17777	
	APPALACHIAN POWER CO	3320	3616.0	10.9	4013	17777	1001

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE LONGITUDE DR.AREA	PROJ.PURP. STATUS AVE. Q	DAM HT MX.STOR. PWR. HD.	EXIST.CAP. INC. CAP. TOT. CAP.	EXIST.ENRG INC.ENERGY TOT.ENERGY	ERC ECONOMIC ERC NONECONOMIC ERC COMPOSITE
		(D M.M)		(FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(D M.M)		(AC FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(SQ.MI)	(CFS)	(FT)	(KW)	(MWH)	(SEQUENCE RANK)
VA6NA00995	DOG ISLAND NO 2	37 43.2		20.0	0	0	
2	NELSON - JAMES RIVER	78 39.0		0	15873	51797	
		4330	4810.0	19.9	15873	51797	2005
VA6NA00133	GLADSTONE PROJECT	37 32.1	H	96.0	0	0	
2	NELSON - JAMES RIVER	78 49.7	IS	195000	86954	203458	
		3670	4160.0	85.2	86954	203458	2004
VA6NA00993	NORWOOD DEVELOPMENT NO 2	37 38.2		20.0	0	0	
2	NELSON - JAMES RIVER	78 45.1		0	15117	49333	
		4124	4577.0	19.9	15117	49333	2005
VA6NA00994	NORWOOD DEVELOPMENT NO 1	37 38.8		140.0	0	0	
2	NELSON - TYE RIVER	78 49.3		0	22054	53879	
		414	560.0	139.8	22054	53879	2005
VAGNA00134	SCHUYLER NO 1 2	37 47.1	H	32.0	0	0	
2	NELSON - ROCKFISH RIVE	78 41.9	OP	0	1354	4431	
	GA MARB	196	290.0	29.9	1354	4431	1002
VAISAW0113	SCHOOLFIELD	39 25.8	H	30.0	4550	21895	
2	PITTSYLVANIA- DAN RIVER	76 34.6	OP	5000	9396	9897	
	DAN RIVER MILLS INC	1890	2072.0	29.0	13946	31793	2004
VAOORN0203	EDMONDSON DAM	36 43.3	H	37.0	0	0	
2	WASHINGTON - M.FK.HOLSTONR	81 48.6	OP	697	0	0	
	APECO	210	240.0	29.9	0	0	2010

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE (D M.M) LONGITUDE (D M.M) DR.AREA (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT (FT) MX.STOR. (AC FT) PWR. HD. (FT)	EXIST.CAP. (KW) INC. CAP. (KW) TOT. CAP. (KW)	EXIST.ENRG (MWH) INC.ENERGY (MWH) TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) ERC NONECONOMIC (SEQUENCE RANK) ERC COMPOSITE (SEQUENCE RANK)
WVCORH0076	BURNSVILLE	38 50.3	CRO	89.0	0	0	
2	BRAXTON - LITTLE KANAWH	80 37.1	OP	65900	0	0	
	DAEN ORH	165	256.0	28.9	0	0	2010
WVCORH0077	SUTTON	38 39.6	CRSO	210.0	0	0	
2	BRAXTON - ELK RIVER	80 41.5	OP	265300	15000	58000	
	DAEN ORH	537	1124.0	111.8	15000	58000	1001
WVHORH0082	HAWKS NEST	38 6.5	H	75.0	102000	551211	
2	FAYETTE - NEW RIVER	81 7.8	OP	0	0	0	
	CARBIDE	6856	8555.0	164.0	102000	0	2010
WVHORH0700	KANAWHA FALLS	38 12.0	H	75.0	5450	37400	
2	FAYETTE - KANAWHA RIVER	81 11.9	OP	0	17095	95493	
	CARBIDE	8340	12500.0	27.9	22545	132893	2005
WVCNAB0167	STONY RIVER POWER STATION DA	39 12.0	O	144.0	0	0	
2	GRANT - STONY RIVER O	79 15.0	OP	51000	0	0	
	VEPCO	31	30.0	133.9	0	0	2010
WVAORP0151	NEW CUMBERLAND L/D	40 31.5	N	64.0	0	0	
2	HANCOCK - OHIO RIVER	80 37.5	OP	0	44000	230000	
	DAEN ORP	23873	37230.0	17.0	44000	230000	1002
WVGNAB0168	MILLVILLE	39 25.0	HRS	26.0	2840	19348	
2	JEFFERSON - SHENANDOAH	77 45.0	OP	0	6149	13384	
	POTOMAC EDISON	3040	3000.0	24.5	8989	32733	1002
WVGORH0090	LONDON L+D	38 11.4	N	42.0	14400	90400	
2	KANAWHA - KANAWHA RIVER	81 22.1	OP	0	4530	30000	
	DAEN ORH	8490	12684.0	19.2	18930	120400	2004
WVGORH0091	MARMET L+D	38 15.1	N	37.0	14400	86475	
2	KANAWHA - KANAWHA RIVER	81 33.5	OP	0	18474	46083	
	DAEN ORH	8816	13171.0	22.3	32874	132558	2004

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID	PROJECT NAME	LATITUDE	PROJ.PURP.	DAM HT	EXIST.CAP.	EXIST.ENRG	ERC ECONOMIC
NUMBER	PRIMARY CO. -NAME OF STREAM	LONGITUDE	STATUS	MX.STOR.	INC. CAP.	INC.ENERGY	ERC NONECONOMIC
ACTV. INV.	OWNER	DR.AREA	AVE. Q	PWR. HD.	TOT. CAP.	TOT.ENERGY	ERC COMPOSITE
		(D M.M)		(FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(D M.M)		(AC FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(SQ.MI)	(CFS)	(FT)	(KW)	(MWH)	(SEQUENCE RANK)
WVCORP0156	STONEWALL JACKSON LAKE	39 0.1	CROS	95.0	0	0	
2	LEWIS - WEST FORK RIV	80 28.4	UC	74650	1057	3962	
	DAEN ORP	102	163.0	67.1	1057	3962	2003
WVAORH0093	GALLIPOLIS L + D	38 40.8	N	44.0	0	0	
2	MASON - OHIO RIVER	82 11.1	OP	0	45000	237000	
	DAEN ORH	53300	79950.0	13.8	45000	237000	1002
WVAORH0094	RACINE L+D	38 55.0	NR	50.0	0	0	
2	MASON - OHIO RIVER	81 54.7	OP	0	44000	231000	
	DAEN-ORH	40130	60195.0	19.1	44000	231000	1002
WV6ORP0160	BEAVER HOLE	39 37.0	H	325.0	0	0	
2	MONONGALIA - CHEAT RIVER	79 47.5	IS	270000	347990	501479	
		1361	2675.4	308.9	347990	501479	2005
WVAORP0162	HILDEBRAND L/D	39 34.9	N	64.0	0	0	
2	MONONGALIA - MONONGAHELA R	80 0.7	OP	0	10504	40860	
	DAEN ORP	2544	4320.0	20.9	10504	40860	1002
WVAORP0161	MORGANTOWN L/D	39 37.1	N	36.0	0	0	
2	MONONGALIA - MONONGAHELA R	79 58.0	OP	6200	6678	29999	
	DAEN ORP	2648	4480.0	16.9	6678	29999	1002
WVAORP0163	OPEKISKA L/D	39 33.7	N	52.0	0	0	
2	MONONGALIA - MONONGAHELA R	80 3.0	OP	0	10757	42232	
	DAEN ORP	2530	4300.0	21.9	10757	42232	1002
WVCORH0103	SUMMERSVILLE	38 13.2	CROS	390.0	0	0	
2	NICHOLAS - GAULEY RIVER	80 53.3	OP	413400	165000	415000	
	DAEN ORH	803	2220.0	261.7	165000	415000	1001
WVAORP0165	PIKE ISLAND L/D	40 9.0	N	64.0	0	0	
2	OHIO - OHIO RIVER	80 42.2	OP	0	44000	230000	
	DAEN ORP	24639	38060.0	17.3	44000	230000	1002

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV, INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE (D M.M) LONGITUDE (D M.M) DR.AREA (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT (FT) MX.STOR. (AC FT) PWR. HD. (FT)	EXIST.CAP. (KW) INC. CAP. (KW) TOT. CAP. (KW)	EXIST.ENRG (MWH) INC.ENERGY (MWH) TOT.ENERGY (MWH)	ERC ECONOMIC (SEQUENCE RANK) ERC NONECONOMIC (SEQUENCE RANK) ERC COMPOSITE (SEQUENCE RANK)
WVAORH0104	WILLOW ISLAND L+D	39 21.1	N	44.0	0	0	
2	PLEASANTS - OHIO RIVER	81 20.2	OP	0	50000	255000	
	DAEN ORH	26900	40350.0	23.7	50000	255000	1002
WV6ORP0167	BIG SANDY CREEK	39 40.9	H	278.0	0	0	
2	PRESTON - BIG SANDY CRE	79 37.7	IS	464000	57364	60091	
		191	406.6	248.5	57364	60091	2005
WV6ORP0166	ROWLESBURG LAKE	39 20.3	H	267.0	0	0	
2	PRESTON - CHEAT RIVER	79 40.6	IS	830000	244566	300951	
		936	2236.4	223.4	244566	300951	2005
WVGORH0113	WINFIELD L+D	38 31.5	NR	47.0	14800	107200	
2	PUTNAM - KANAWHA RIVER	81 54.8	OP	0	0	0	
	DAEN ORH	11809	16582.0	27.9	33000	115000	2004
WVCORH0116	BLUESTONE	37 38.4	CRO	165.0	0	0	
2	SUMMERS - NEW RIVER	80 53.2	OP	631000	55000	210000	
	DAEN ORH	4565	5668.0	36.9	55000	210000	2003
WVCORP0170	TYGART RIVER DAM	39 18.7	CROS	230.0	0	0	
2	TAYLOR - TYGART RIVER	80 1.9	OP	287700	60000	103100	
	DAEN ORP	1184	2324.0	130.0	60000	103100	1001
WVCORH0118	BEECH FORK	38 18.1	CRO	86.0	0	0	
2	WAYNE - BEECH FORK	82 24.5	OP	37450	0	0	
	DAEN ORH	78	86.0	34.9	0	0	2010
WVCORH0119	EAST LYNN	38 5.9	CRO	113.0	0	0	
2	WAYNE - EAST FORK TWE	82 23.1	OP	82500	0	0	
	DAEN ORH	133	158.0	61.9	0	0	2010
WV6ORH0120	ELK RIVER	38 28.0	C	194.0	0	0	
2	WEBSTER - ELK RIVER	80 7.9	IS	0	67000	79000	
	DAEN ORH	273	716.0	188.8	67000	79000	2005

EXHIBIT 1: INVENTORY, ECAR REGIONAL PLAN

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE LONGITUDE DR.AREA	PROJ.PURP. STATUS AVE. Q	DAM HT MX.STOR. PWR. HD.	EXIST.CAP. INC. CAP. TOT. CAP.	EXIST.ENRG INC.ENERGY TOT.ENERGY	ERC ECONOMIC ERC NONECONOMIC ERC COMPOSITE
		(D M.M)		(FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(D M.M)		(AC FT)	(KW)	(MWH)	(SEQUENCE RANK)
		(SQ.MI)	(CFS)	(FT)	(KW)	(MWH)	(SEQUENCE RANK)
WVAORP0173	HANNIBAL LOCKS AND DAM	39 39.2	N	21.0	0	0	
2	WETZEL - OHIO RIVER	80 51.7	UP	300000	44000	230000	
	DAEN ORP	25967	39640.0	18.7	44000	230000	1002
WVAORH0126	BELLEVILLE L+D	39 5.9	NR	41.0	0	0	
2	WOOD - OHIO RIVER	81 44.3	UP	0	50000	255000	
	DAEN ORH	39350	59025.0	32.5	50000	255000	1002
WVCORH0127	R.D. BAILEY	37 30.0	CRO	310.0	0	0	
2	WYOMING - GUYANDOTTE RI	81 50.0	UC	203700	17730	53000	
	DAEN ORH	540	768.0	140.8	17730	53000	1001

NUMBER OF SITES SATISFYING CONSTRAINTS = 194

COMMAND AND CONSTRAINTS END

NATIONAL HYDROPOWER STUDY
VOLUME XVII
EAST CENTRAL AREA ELECTRIC RELIABILITY COUNCIL

Appendix B
PUBLIC INVOLVEMENT

FEDERAL ENERGY REGULATORY COMMISSION
CHICAGO REGIONAL OFFICE
230 SOUTH DEARBORN STREET, ROOM 3130
CHICAGO, ILLINOIS 60604

In reply refer to:
OEPR-CH-HRA

April 14, 1981

Mr. Harold W. Beemer
Chief, Planning Division
Ohio River Division
Corps of Engineers
P.O. Box 1159
Cincinnati, Ohio

Dear Mr. Beemer: Your Reference: ORDPD-F

We have reviewed the draft of the National Hydroelectric Power Study for the "ECAR" Region which you sent with your February 25 letter.

The general approach used in the study to identify those hydroelectric sites which offered the best prospects for development under present economic conditions is acceptable. However, we note that at some of the sites the proposed plant would operate at a high annual capacity factor, even in instances where there are to be capacity additions. Since an increase in benefits could result from operating at a lower capacity factor, or peaking-type operation, consideration should be given to increasing the installation at those sites where streamflow could be regulated without environmental damage. Application of the concept of diminishing returns to size the plant installation, a concept that you propose to use in your detailed planning studies for the sites, might allow the installed capacity to be increased. Escalating fuel costs of alternate sources of energy would also tend to favor larger installations.

Some of the sites identified in the report either have plants operating under licenses issued by FERC or have application for licenses pending. A number of the other sites either have preliminary permits in effect or have applications for preliminary permits pending. Since the hydropower potential of these sites may have been recently studied, it would be advantageous for you to review the studies which may have been performed before undertaking additional investigation.

Thank you for the opportunity to comment.

Sincerely,

Clifford L. Emmerling

for Lawrence F. Coffell, P.E.
Regional Engineer

SUSQUEHANNA RIVER BASIN COMMISSION
1721 North Front Street • Harrisburg, Pennsylvania 17102

From the Office of the
Executive Director

March 5, 1981

Mr. Harold W. Beemer, Chief
Planning Division
Ohio River Division
Corps of Engineers
P.O. Box 1159
Cincinnati, OH 45201

Attn: ORDPD-F

Dear Mr. Beemer:

Thank you for providing us with the Draft ECAR Regional Report for our review. The SRBC staff has the following comments concerning the report.

1. Table 3.1 (page 15):

We question the wisdom of including the long time (1965-79) averages of annual growth rates for both electric energy and peak loads. As your report goes on to point out, "Rates of increase have been lower since the 1973 embargo year." Thus, casual reference by a reader to only the averages could lead to erroneous conclusions.

2. Section 3.2 (pages 18-19):

We fail to see the need for inclusion of Projection III, the so-called "Consensus Forecast". Moreover, we do not understand characterizing it as an "average" or "middle ground" forecast in view of the fact that it gives the highest forecasted values.

3. <u>Comments About Projects Lying in the Susquehanna River Basin</u>:

Site No.: PACNAB 0053
Project Name: Foster Joseph Sayer

We commented on this project to North Atlantic Division during the Stage 3 screening process. At that time, we noted that development of a hydroelectric project at the site could have major impacts on existing authorized purposes. To elaborate further, Bald Eagle Creek, an alkaline stream, is important to the water quality of the West Branch Susquehanna River. The existing releases from the Sayer Reservoir are a major factor in controlling any acidity in the West Branch below Lock Haven. A release scheme from a hydro facility with peaking capacity could conflict with the water quality enhancing effect of the Sayer project. To the extent that such a conflict would occur, there may be a detrimental impact on the water quality of the West Branch. We request that you review this situation before your report is released in final form.

Site No.: PACNAB 0125
Project Name: George B. Stevenson

We note that this project's plan designation identifies it as a site which could be developed after 1995. We call your attention to the fact that downstream of the site First Fork will support trout. Any review of the site for hydrogeneration purposes should, in our view, include consideration of the impacts on the downstream habitat that result from changes in the flow release regimen.

* * * * *

I am sure the study will be a useful contribution to our knowledge of hydropower development potential in the ECAR area. We appreciate the opportunity to comment on the draft report.

Sincerely,

Robert J. Bielo
Executive Director

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

East Lansing Area Office
Manly Miles Building, Room 202
1405 South Harrison Road
East Lansing, Michigan 48823

March 23, 1981

Mr. Harold W. Beemer, Chief
Planning Division
Ohio River Division
Corps of Engineers
P.O. Box 1159
Cincinnati, Ohio 45201

RE: Draft ECAR Regional Report, National Hydropower Study

Dear Mr. Beemer:

As requested, we have reviewed the subject document and have the following comments.

Section 4.6, Parameters Governing Use of Hydropower, should include comments on environmental constraints associated with hydroelectric power generation. At a site without an existing structure, this would include construction of a dam and creation of an impoundment, with concomitant inundation of a free-flowing stream and terrestrial habitat. Competing and conflicting land-use and water-use issues are involved.

At both existing and newly-constructed reservoirs, major features of hydroelectric operation that can affect reservoir and tailwater ecosystems are the amount of water released (which will affect the water level), the degree of daily water level fluctuation, and the depth of water withdrawal from the reservoir. Water level fluctuations in particular can adversely affect both tailwater and reservoir fisheries.

Sincerely yours,

John Popowski

Area Manager

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

East Lansing Area Office
Manly Miles Building, Room 202
1405 South Harrison Road
East Lansing, Michigan 48823

March 13, 1981

Mr. Harold W. Beemer
Chief, Planning Division
U.S. Army Engineer District
Ohio River Division
P.O. Box 1159
Cincinnati, Ohio 45201

Dear Mr. Beemer:

We have reviewed the draft, "National Hydroelectric Power Resources Study, Regional Report, Volume XVII," for the East Central Area Electric Reliability Council. The report provides much useful information on potential hydropower in the region. We have, however, no substantive comments to offer on this report.

Thank you for the opportunity to review this portion of the National Hydroelectric Power Resources Study. If additional information is developed we would like to obtain the documents.

Sincerely yours,

John Topowski

Area Manager

cc: Regional Director, Twin Cities, MN (RA)

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
One Gateway Center, Suite 700
NEWTON CORNER, MASSACHUSETTS 02158

4 MAR 1981

Mr. Harold W. Beemer, Chief
Planning Division
U.S. Army Engineer Division
Ohio River Division
P.O. Box 1159
Cincinnati, OH 45201

Dear Mr. Beemer:

We have reviewed the Draft ECAR Regional Report (National Hydropower Study) and offer the following comments for consideration in development of your final report.

It has been our experience that hydropower expansion proceeds most rapidly and efficiently when developers recognize the need for early consultation with fish and wildlife management agencies. In most cases, development interests benefit by knowing what ecological values to consider and how best to avoid unnecessary degradation. Such knowledge invariably facilitates detailed project planning and licensing, avoiding costly and needless delays.

Your final report would benefit from expansions of Section 4.6 and 8.3, directed toward communicating this important message. Without doubt, you would be enhancing your efforts to facilitate hydropower development.

Sincerely yours,

Regional Director

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
6TH AND WALNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

MAR 3 1 1981

Mr. Harold W. Beemer
Chief, Planning Division
Ohio River Division
Corps of Engineers
P.O. Box 1159
Cincinnati, Ohio 45201

Attn: ORDPD-F

Dear Mr. Beemer:

We have completed our review of the Draft ECAR Regional Report, National Hydropower Study.

As this is a generic report it is very difficult to appraise the proposal; there are too many variables.

We would however, like to comment on the lack of information on some topics and the inclusion of some alternatives as part of the thinking about the subject of hydropower. Our comments are itemized below.

1. We did not see any consideration of the safety classification developed by the COE inspection reports. We have received feasibility reports and permit applications for dams that have been classified on three successive inspection reports as "highly hazardous" and the ignoring of recommendations made by the inspectors. We do not believe it would be very sound judgement to install hydropower in a facility classified in this manner. Other dams have been considered that were in a more hazardous state.

2. We do not support the proposition of constructing new dams just for hydropower purposes. We concur with the use of existing dams using the run of the river for the energy.

3. EPA questions the use of any existing dam as part of a pumped storage facility. We consider pumped storage to have questionable energy consumption impacts and to be in many instances environmentally unsound.

4. We would like to see at least an environmental assessment on any proposed site regardless of the size of the unit. Under certain conditions small facilities can be just as damaging as large ones.

5. Finally, we think that all proposals should be justified by an acceptable benefit cost ratio.

We thank you for the opportunity to review this report and offer our comments.

Sincerely yours,

for John R. Pomponio
Chief
EIS & Wetlands Review Section

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
P. O. Box 1467
Harrisburg, Pennsylvania 17120

Office of the Deputy Secretary
Resources Management
717-783-5338

March 26, 1981

In reply refer to
RM-R
HP 0:1

Harold W. Beemer, Chief
Planning Division
Department of the Army
Ohio River Division - C.O.E.
P. O. Box 1159
Cincinnati, Ohio 45201

Dear Mr. Beemer:

We have reviewed the Draft ECAR Regional Report on the National Hydropower Study and generally concur with its assessment of hydropower potential within the related portion of the Commonwealth.

A minor exception is taken to Chapter 7. The Corps has classified the inventory of dams in the following categories:

1. C.O.E. owned multipurpose project
2. C.O.E. navigation project
3. Non-Federal owned single purpose project
4. Existing hydropower project with additional potential
5. Undeveloped sites

While most of the dams inventoried may fall into one of these categories, it should be noted that the George B. Stevenson Dam is a Non-Federally owned multipurpose dam.

The conclusion in Chapter 9 that in general existing project functions must be maintained and that pool fluctuation criteria for reservoirs must be developed on a site specific basis is fully supported by the Department. We also concur with the first statement on Page 63 which says "state natural resource agencies indicate that very stringent restraints on fluctuations would be required at state developed recreation lakes."

We appreciate the opportunity to comment on the Corps' draft report and would like to receive a copy of the final report.

Sincerely,

R. Timothy Weston

R. Timothy Weston
Associate Deputy Secretary
for Resources Management

ODNR
Ohio Department of Natural Resources
DIVISION OF WATER
Fountain Square • Columbus, Ohio 43224 • (614) 466-4768

March 31, 1981

Mr. Harold W. Beemer
Chief, Planning Division
U. S. Army Engr. Div., Ohio River
P. O. Box 1159
Cincinnati, OH 45201

SUBJECT: Draft ECAR Regional Report, National Hydropower Study

Dear Mr. Beemer:

Director Robert W. Teater forwarded to me his copy of the subject draft report. My staff has reviewed the draft report and particularly the 38 Ohio sites listed in Exhibit 1. They report that a realistic appraisal of potential hydroelectric power development is presented for both the ECAR Region and Ohio. Several minor comments are noted concerning the Ohio sites listed in Exhibit 1. These are:

1. The East Falls site in Lorain County (ID No. OHANCB4321) is indicated to have a potential capacity of 17,405 kilowatts. This appears to be quite high considering the average flow and indicated power head and should be re-checked.
2. The Gorge Dam site (ID No. OHANCB4322), indicated as being in Portage County, is actually located in Summit County. Also, a capacity of 14,455 kilowatts is listed for this site, yet the F.E.R.C. order issuing a Preliminary Permit for Project No. 3091 at this site indicates a capacity of only about 5,500 kw.
3. The Michael J. Kirwin site (ID No. OHCORP0033) is correctly spelled "Kirwan".

Some of the Ohio sites listed in Exhibit 1 appear to be quite marginal and may not survive more detailed engineering, economic and environmental studies. Conversely, a few additional sites will likely be considered by various interests and several may be determined feasible. We note that the F.E.R.C. has issued preliminary permits for several Ohio sites not listed in Exhibit 1. From an overall standpoint, however, the report will serve as a practical and useful guide to potential hydropower development in this region.

Sincerely,

JOHN H. COUSINS
Chief

JHC/ww
cc: Bob Lucas

United States Department of the Interior
FISH AND WILDLIFE SERVICE
75 SPRING STREET, S.W.
ATLANTA, GEORGIA 30303

MAR 25 1981

Division Engineer
U.S. Army Corps of Engineers
Ohio River Division
P.O. Box 1159
Cincinnati, Ohio 45201

Dear Sir:

This is in response to the letter dated February 25, 1981, from Harold W. Beemer, Chief, Planning Division, transmitting the Draft ECAR Regional Report, National Hydropower Study, Volume XVII, December 1980. Comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

The document appears to cover the important aspects of population growth and electricity demands within the Ohio River Basin, existing resources, various constraints and other factors pertaining to hydropower resources and development. We noticed that a small area in and around Kingsport, Tennessee, was evaluated, but in the text and inventory of potential sites, none were referenced or listed. Likewise, a discrepancy appears to have surfaced for sites in Kentucky. Tables 8.1 and 8.2, pages 56 and 58, list a total of 35 sites within this State, however, Exhibit 1, pages 3 through 7, lists 43 sites for Kentucky.

We commend the Corps for including fish and wildlife needs, especially water level fluctuations and instream flow requirements, during the early planning process. To assist your staff in organizing necessary fish and wildlife information, we have included a copy of the Fish and Wildlife Service (FWS) Hydropower Site Assessment Form (copy attached). This useful tool allows the collecting and organizing of relevant site specific information for both federal and non-federal projects.

At this early planning state we have concerns about the cumulative impacts from several store-and-release dams throughout a watershed in a low-flow situation. For selected watersheds where this problem may arise, we request that your agency perform a SPLASH model analysis. SPLASH is a computer program designed by the FWS to aid in the environmental assessment of hydropower projects. SPLASH is especially tailored to consider cumulative hydrologic changes induced by one or more store-and-release arms operating under a variety of conditions. Of particular importance is the model's ability to simulate hydrologic conditions during periods of low flow, critical to survival of fish and aquatic invertebrates. SPLASH allows users to place hydrologic constraints on the design and operation of low head hydroprojects in order to facilitate making decisions covering downstream minimum flow requirements and reservoir (storage pool) volume fluctuations. SPLASH helps identify when extreme or adverse hydrologic conditions may occur; where such conditions may occur; and what types of problems may occur at these locations. Ultimately, this information can be used to identify the fish and wildlife species that may be affected and in what way. A copy of the 31-page user's manual is available upon request.

At this time we refrain from commenting on specific sites. Our Asheville Area Office and Cookeville Field Station will provide appropriate input to the individual Corps Districts with jurisdiction over feasible sites.

We urge the adoption of the attached FWS Hydropower Site Assessment Form and implementation of the SPLASH model analysis. The provisions for funding of detailed fish and wildlife studies by the FWS should be included as an integral part of any proposed authorization.

Sincerely yours,

Acting Regional Director

Attachment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

4E-ER/WET

345 COURTLAND STREET
ATLANTA, GEORGIA 30365

MAR 16 1981

Mr. Harold W. Beemer
Chief, Planning Division
U.S. Army Corps of Engineers,
Ohio River Division
P. O. Box 1159
Cincinnati, Ohio 45201

SUBJECT: Draft ECAR Regional Report National Hydropower Study

Dear Mr. Beemer:

This is in response to your letter of February 25, 1981, relating to the report on the potential for hydroelectric power development in the East Central Area Reliability Coordination Agreement (ECAR) Region.

The document is well prepared and meets the objectives outlined in the report. Although we realize it is not the intent of the report to outline the environmental aspects of hydropower development, we believe it would be appropriate to delineate some of our concerns so that they could be given early consideration as the projects are carried forward.

The Environmental Protection Agency's main concerns with regard to power development lie primarily with the impacts of the projects on the natural environment and water quality values. With regard to the twenty undeveloped sites in the ECAR Region which have potential for hydroelectric power development, the environmental impact can be greatly reduced by locating the dam sites so as to cause minimal impact on wetlands and wildlife and by designing the dams for minimal impact on water quality. Also, there are mitigative measures which can be taken to improve water quality in making revisions to existing facilities.

The main deficiencies with regard to dams and reservoir construction relate to the anaerobic conditions which develop in hypolimnion of stratified reservoirs which results in low PH, low dissolved oxygen, heavy metals and other toxicants going into solution and being carried downstream and low dissolved oxygen and poor assimilative capacity below the dams.

Techniques for correcting reservoir problems include more effective control of non-point source pollution such as soil conservation practices, aeration or oxygenation of reservoir bottoms, rearation of turbine and reservoir releases, multilevel intakes and adjustment of operation schedules.

The most promising method of correcting low dissolved oxygen below high dams was recently demonstrated by the Tennessee Valley Authority at the Norris Dam. The system includes a "hub baffle" which is formed by welding baffles above the vents on the hub of the turbine which increases suction, causing more air to mix with the water, and by supplying air and a baffle ring inside the draft tube, the pipe that drains water from the turbine to the river below the dam. The combination of "hub baffle" and draft tube ring is reputed to increase oxygen levels from 3.5 to 4.5 mg/l at a cost of about $15,000 per unit. The system is considered as being a breakthrough in solving the problem of low dissolved oxygen below hydroelectric dams.

Although this system will not solve the reservoir eutrophication problems and the carryover of heavy metals and toxicants downstream, it will greatly improve water quality and the assimilative capacity of the stream below the dam. It will supply the oxygen needed to support fish life and the natural purificational processes which further break down the remaining organic substances contained in the water. Also, where there are a series of dams and reservoirs it will greatly improve water quality values within the reservoirs downstream and slow down the eutrophication process.

Sudden intermittent releases of water from the reservoirs resulting from hydroelectric power peaking operations can significantly affect water temperature and also water quality below the dam. Multilevel inlets to the turbines can frequently be of help in this regard.

The opportunity of reviewing and commenting on the environmental aspects of power development is greatly appreciated.

Sincerely yours,

Arthur G. Linton, P.E.
Federal Facilities Coordinator
Enforcement Division

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

REPLY TO ATTENTION OF:

1 A

Mr. Howard W. Beemer
Chief Planning Division
Department of the Army
Ohio River Division, Corps of Engineers
P.O. Box 1159
Cincinnati, Ohio 45201

Dear Mr. Beemer:

We have completed our review of the Draft ECAR Regional Report, National Hydropower Study. This report was sent to us on February 25, 1981, and requested our comments by April 1, 1981.

The evaluation of hydroelectric potential in the ECAR Region began with an inventory of existing dams and potential dam sites. This resulted in 4500 dams having hydroelectric potential. Several screening procedures were used, including cost benefit analysis to pare the number of potential hydroelectric dams to 194. The evaluation should further consider the changing economic factors which may make additional hydroelectric units feasible.

Of the 194 hydroelectric facilities considered, 20 of these are at underdeveloped sites. Exhibit 1 should be more clearly define which of the 194 are the undeveloped sites.

We appreciate the opportunity to review this draft report. If you have any questions in regard to our comments, please contact Mr. Bill Branz at FTS 886-6687 or COM. 312/886-6687.

Sincerely yours,

William D. Franz

fr

Barbara J. Taylor, Chief
Environmental Impact Review Staff
Office of Environmental Review

OWEN LENTZ, Executive Manager

ECAR

EXECUTIVE OFFICE: P. O. BOX 102, CANTON, OHIO 44701
PHONE (216) 456-2488

March 31, 1981

National Hydroelectric Power Resources Study
Regional Report: Volume XVII
East Central Area Electric Reliability Council
December 1980

Mr. Harold W. Beemer
Department of the Army
Ohio River Division
Corps of Engineers
P. O. Box 1159
Cincinnati, Ohio 45201

Dear Mr. Beemer:

In response to your request of February 25, 1981, you will find enclosed a copy of comments on the subject report. We appreciate the opportunity to review this report. If we can be of any further assistance, please feel free to contact this office.

Very truly yours,

O A Lentz

Owen A. Lentz
Executive Manager

OAL:dlr

Enclosure

U.S. Army Corps of Engineers
National Hydro Electric Power Resources Study
Regional Report - Volume XVII
East Central Area Electric Reliability Council
December 1980

Comments by ECAR

As is brought out in the preface of the report, the role of hydro as a renewable source of energy should not be overlooked in our endeavor to provide adequate and reliable electric power. It is evident that the Corps of Engineers in its regional National Hydro Electric Power Resources Study (NHS) has responded to the directive of Congress to determine the amount and feasibility of increasing the country's hydroelectric capability. These reports should be most useful in assessing and establishing an overall national energy policy and programs to meet the country's future energy needs.

We concur with the observation under section 4.5, Potential Role of Hydro Power, that hydro can only play a complementary role as an energy source for the region. Thus, it is the purpose of the following comments to offer our thoughts on hydro's complementary regional role to the extent it can be derived from its operational characteristics as set forth on page 36 of the report. For clarity, we have numbered and repeated the six operational characteristics and identified our response.

1. *Hydroelectric can improve system reliability because near-term availability of water is predictable and hydro turbines experience low maintenance and repair requirements compared to outage rates of coal-fired and nuclear-fired plants.*

RESPONSE--This statement is true if one defines "improve system reliability" as being near-term or day-to-day reliability. On a day-to-day basis an operator should be in the best position to judge whether river conditions are in:

(a) a period of low flow conditions with little or no water,

(b) a period of optimum river flow with maximum head and quantity of water equal to the turbine capability, or

(c) a period of too much water with no head; i.e., a flood condition.

As the period of forecast is increased, the prediction of reliability inherently becomes less reliable. The extent to which a hydro project can contribute to "long-term system reliability" depends on evaluating the historic records of river characteristics. Predicting the availability of water in future years by a statistic analysis is less reliable than near-term day-to-day forecasts. Any capacity value assigned to a site for system planning purposes can be significantly less than the installed capacity. From experience, it is known that hydro output in different sections of the country has been restricted from time-to-time due to drought conditions.

2. *Hydroelectric can increase system flexibility. Mechanical adjustments to change the energy output from hydro turbines can be accomplished in seconds. Even with operational constraints to avoid adverse environmental impacts, hydro can add significant flexibility to ECAR's coal-fired electrical systems.*

RESPONSE--It is true that a hydroelectric unit or plant could increase system flexibility if the size of the unit or plant is a significant portion of the system generation and there is complete flexibility in utilizing the available water to control the output of units. However, in relating this feature to the ECAR Bulk Power Network one must visualize the problem that would be involved in controlling many small units to respond to a system emergency. For example, the sudden loss of 1,500 or 2,000 MW of generation is not uncommon. Thus, it's questioned that it would be practical to provide the controls necessary to increase the output of a sufficient number of units to make a significant contribution to such deficiencies.

3. *Hydroelectric can reduce the use of oil by operating to meet peak electric demands. Consistent with other project purposes and environmental design criteria, many hydro projects in ECAR could be operated to follow daily variations in demand. This load-following capability could be utilized to displace some of the 30 million barrels of oil consumed annually by ECAR utilities.*

RESPONSE--This statement is true if the system generating reserve margin is established by excluding oil-fired peaking equipment from the analysis; i.e., the equipment is retired or put in standby operation. If this is not the case, then hydro can only help minimize the use of oil by pushing such peaking units "further up" in the load curve to reduce their operating hours. However, with growth in peak demand the hours of operation of oil-fired peaking capacity may not change significantly.

4. *Hydroelectric at storage projects can provide an emergency reserve. A small amount of water flow can keep a hydro turbine spinning so that it may be brought on line very quickly in the case of a system emergency. In the event of a system failure, hydro can provide the energy necessary to start up ECAR's large thermal generators.*

RESPONSE--The first two statements are true but as noted above, are not practical for the ECAR area. Too many units would be involved in a complex control scheme to contribute significantly to an emergency condition. To keep the turbine spinning while awaiting an emergency event would probably be a waste of water which could be better used to displace higher cost energy; i.e., there are better and less costly ways to provide the necessary operating reserves to meet emergencies.

The second statement is true. In a number of cases, hydro of sufficient size and in the right location, could act as a "cranking" source for thermal plants following a major system outage.

5. *On a regional basis, reliable hydroelectric capacity could forestall the need for additional gas or oil-fired capacity and could replace these types of units as they are retired.*

RESPONSE--It's not clear why this statement starts with the phrase "On a regional basis..." This statement would be more true if it were on the basis of a "system." To the extent a unit or group of units can perform the same or comparable peak load function within a system load curve as oil or gas-fired peaking units, it would forestall the need for such peaking capacity. The ability to do this would depend on river flow characteristics, pondage, and other constraints on containment and release of water.

6. *Hydro in ECAR can also play a significant role on a local basis in ECAR providing the smaller systems with significant amounts of energy. Hydro's importance is related to the size of the facility compared to the system it serves. While a 15 MW plant may not be regionally significant, it may be very important to a smaller system where peak demand is in the range of 50 MW. Since the hydro resource in ECAR is distributed throughout the region, its future role lies with the scattered small utilities in the region rather than with the large bulk power systems.*

RESPONSE--This statement puts in perspective the role of hydro in the ECAR area. As noted in the report, the 3,000 MW of projected hydro is spread among 200 sites or an average of 15 MWs per site. Furthermore, the characteristic of a large portion of the hydro is run of river or sites of limited pondage and/or constraints on variation in the ponding and release of water. The statement emphasizes why most of the justifications (or benefits of the hydro) given above in 1 through 5, are very marginal. Whether it be for a large or small system, the primary justification for most of the hydro would be as an economical energy source to displace generation with high fuel cost. To the extent any particular site can be judged as contributing to firm power; i.e., evaluated as capacity, this additional benefit would be recognized in its economic justification beyond that of displacing generation with high fuel cost.

In the second paragraph of section 9.1, Existing Supply and Demand, the second sentence states "On a typical weekday, an average of 21 percent of ECAR's generating capacity is unavailable for service." ECAR members have experienced an average unavailability of generation from all causes; planned maintenance, condition derate, partial outages, and forced outages in the range of 27 percent to 30 percent in recent years. The 21 percent quoted is the "random" component of unavailability; i.e., it does not include planned maintenance.

A limited review has been made of Exhibit 1, which identifies candidate sites for new or additional hydro capacity together with data on river flow, megawatt-hour output, etc. No specific studies have been made of the various sites. Thus, we are in no position to determine if additional capacity is physically or economically practical at this time. Each site will require careful economic analysis with proper consideration of environmental and recreational ramifications before it can be justified. However, a copy of Exhibit 1 was sent to all ECAR members for their review, and we would call attention to the information which follows concerning rating of present equipment and/or historic output which differs to varying degrees with the listing of Exhibit 1.

We would also call attention to a report prepared in a cooperative effort between the U.S. Department of Energy and the Kentucky Department of Energy. The report entitled, "Small-Scale Hydro Power--Resource Assessment for Kentucky, November 1980," indicates considerable differences in data for numerous hydro sites as to capability that could be installed and the resulting MWH output. The variance in data probably results from the different criteria used in evaluating the extent to which each site should be developed for the most economic benefits.

OAL:dlr
3/31/81

Hydro Sites, Michigan

Comparisons of MWH Output of Hydro Plants
Operated by Consumers Power Company

	Corps Exhibit I	CPCo (49-Year Average)
Alcona	41,443	25,463
Webber	15,822	10,181
Foote	35,141	29,434
Loud	22,371	18,385
Rogers	28,789	26,862
Croton	39,052	37,482
Hardy	93,732	86,536

OAL:dlr
3/31/81

Northern Indiana Public Service Company
Hydroelectric Power Data
National Hydro Electric Power Resources Study

Site ID Number Actv. Inv.	Project Name Primary Co. Name of Stream Owner	Latitude Longitude Dr. Area (D.M.M.) (D.M.M.) (Sq. Mi.)	Proj. Purp. Status Ave. Q (CFS)	Dam Ht. Mx. Stor. Pwr. Hd. (FT) (AC FT) (FT)	Exist. Cap. Inc. Cap. Tot. Cap. (KW) (KW) (KW)	Exist. Energy Inc. Energy Tot. Energy (MWH) (MWH) (MWH)	ERC Economic ERC Noneconomic ERC Composite (Sequence Rank) (Sequence Rank) (Sequence Rank)
IN00RL0099	Norway Dam [1,2]	40 46.8	HR	32	4,000	24,658	
2	White	86 45.6	OP	15,400	0	0	
	Tippecanoe R.	1732	1,500	30	4,000	24,658	2,005
	NIPSCO						
IN00RL0029	Oakdale Dam [3,4]	40 39.4	HR	58	6,000	30,616	
2	Carroll	86 45.2	OP	40,540	0	0	
	Tippecanoe R.	1860	1,600	45	6,000	30,616	2,005
	NIPSCO						

[1]The total installed capacity for the Norway Dam is 6,720 KW, as reported in FPC Form No. 1. Sufficient water flow is available only to consider the existing capacity of this site as 4,000 KW for planning and reporting purposes (this value is shown in Column 6 of the table). No estimate of any potential capacity due to lack of water.

[2]The existing annual MWH output and the total potential annual energy for Norway should be 24,658 MWH. This is the average plant output for the last 21 years.

[3]The total installed capacity for the Oakdale Dam is 11,000 KW, as reported in FPC Form No. 1. Sufficient water flow is available only to consider the existing capacity of this site as 6,000 KW for planning and reporting purposes (this value is shown in Column 6 of the table). No estimate of any potential capacity due to lack of water.

[4]The existing annual MWH output and the total potential annual energy for Oakdale should be 30,616 MWH. This is the average plant output for the last 21 years.

3/31/81

MARYLAND

DEPARTMENT OF STATE PLANNING

301 W. PRESTON STREET
BALTIMORE, MARYLAND 21201

HARRY HUGHES
GOVERNOR

CONSTANCE LIEDER
SECRETARY

April 15, 1981

Mr. Harold Beemer
Chief, Planning Division
Department of the Army
Ohio River Div. - Corps of Engineers
P. O. Box 1159
Cincinnati, Ohio 45201

SUBJECT: PROJECT NOTIFICATION AND REVIEW

Applicant: Army Corps of Engineers

Project: Draft ECAR Report on Hydroelectric Power Resources Study for the East Central Area

State Clearinghouse Control Number: 81-3-665

State Clearinghouse Contact: James McConnaughhay (383-2467)

Dear Mr. Beemer:

The State Clearinghouse has reviewed the above project. In accordance with the procedures established by the Office of Management and Budget Circular A-95, the State Clearinghouse received comments from the:

Dept. of Natural Resources, Dept. of Economic and Community Development, including their Historical Trust section, Public Service Commission, Tri-County Council for Western Maryland, and our staff noted that the project is not inconsistent with their plans and programs.

The Natural Resources Department also provided information (attached) regarding their concern on the potential adverse impacts of increased peaking power generation at dams on water quality and aquatic resources. The Department also questioned the accuracy of the electric power demand projections presented in the Study.

As a result of the review, it has been determined that the proposed project is not inconsistent with State plans, programs and objectives as of this date. However, the concern of the Department of Natural Resources should be properly considered and addressed.

Sincerely,

J. W. McConnaughhay

James W. McConnaughhay
Director, State Clearinghouse

JWM:BG:mmk

cc: T. Hatem/M. Wagner/L. Frederick/H. Sachs

TELEPHONE: 301-383-2467
OFFICE OF STATE CLEARINGHOUSE

Date:

Maryland Department of State Planning
State Office Building
301 West Preston Street
Baltimore, Maryland 21201

DEPT. OF STATE PLANNING
RECEIVED
APR 15 1981
REVIEWED
ANSWERED

SUBJECT: PROJECT SUMMARY NOTIFICATION REVIEW

Applicant: Army Corps of Engineers

Project: ECAR Draft Hydropower Study

State Clearinghouse Control Number: 81-3-665

CHECK ONE

This agency has reviewed the above project and has determined that:

1. The project is not inconsistent with this agency's plans, programs or objectives and where applicable, with the State approved Coastal Zone Management Program. ____

2. The project is not inconsistent with this agency's plans, programs or objectives, but the attached comments are submitted for consideration by the applicant. ✓

3. Additional information is required before this agency can complete its review. Information desired is attached. ____

4. The project is not consistent with this agency's plans, programs or objectives for the reasons indicated on attachment. ____

Signature: ____________________

Title: Acting Director

Agency: [illegible]

Address: Department of Natural Resources
Annapolis, Md. 21401

J COULTER
SECRETARY

BUREAU OF MINES
ENERGY OFFICE
POWER PLANT SITING PROGRAM

STATE OF MARYLAND

DEPARTMENT OF NATURAL RESOURCES
ENERGY ADMINISTRATION
TAWES STATE OFFICE BUILDING
ANNAPOLIS 21401
(301) 269-2261

April 10, 1981

Mr. James W. Mc Connaughhay
Director, State Clearinghouse
Department of State Planning
301 West Preston St.
Baltimore, Maryland 21201

Dear Mr. McConnaughhay:

This is in reference to State Clearinghouse Control Number 81-3-665. The document presents a review of the potential for hydropower development in the ECAR region, which includes Western Maryland.

The referenced document is not, in general, inconsistent with the Department's plans and objectives. However, several specific comments should be brought to the attention of the Corps of Engineers.

The document identifies as candidates for new or additional hydropower development Bloomington Dam, Potomac River Dam No. 4, and Potomac River Dam No. 5. We are concerned about the potential impact of increased peaking power generation on aquatic resources.

The Maryland Power Plant Siting Program is currently conducting studies in the Susquehanna River to resolve questions concerning the impact of the present operating regime of Conowingo Dam. These studies will cost in excess of $1 million when completed. The studies are designed to investigate environmental impacts which appear to have resulted from the expansion of the Conowingo generating capacity in the late 1960's.

The addition of the four large generating units at Conowingo has resulted in an increase in the peaking power operating regime of the dam. That operating regime has had the effect of increasing the frequency of periods in which no water passes through the dam and the lower portion of the Susquehanna River is dewatered. A preliminary review of the data available indicates that this newer operating schedule may be responsible for both reduction in river water quality and a reduction in the aquatic habitat available to support fish species in the river.

Should our analysis indicate that the operating regime of Conowingo is responsible for poor water quality and habitat conditions in the lower Susquehanna, it is likely that a continuous flow regime would be recommended as a mitigating measure. Such a regime would be likely to be incompatible with additional peaking power generation, unless that generation is spread over a very short period of time. On the other hand, an increase in generation during off-peak periods, an increase in generation in high-flow periods when the dam is not storing water, and run-of-river generation would not be incompatible with such a continuous flow regime. The economic analysis for this generating schedule is different than that for a peak generation scheme, and is likely to lead to a different cost/benefit finding, however.

The Department supports the development of hydroelectric potential at existing dams where that development is not unduly harmful to aquatic resources. We are concerned, however, that peaking power generating patterns that result in stream dewatering and poor water quality and habitat conditions may have serious impact on aquatic resources. We recommend that these impacts be carefully evaluated on a case-by-case basis before the expansion of peaking generation at existing dams such as the Maryland dams included in the ECAR region document is proposed, and that the economic analysis of hydropower development be based on a generating schedule which incorporates an acceptable minimum flow pattern.

We would also like to address the Corps' attention to the electric power demand projections contained in Chapter 3 of the referenced document. The estimates for peak demand and energy growth for the Allegheny Power System shown in Table 3.4 appear to significantly overstate extent projections for that system. Other tables and figures in that chapter, which incorporate those projections, as well as computations of the economic benefits of hydropower generation based on those estimates, would appear to be in error as a result.

The Maryland Power Plant Siting Program prepares independent demand forecasts for each of the Maryland electric utility systems. Forecasts for the APS system were prepared in the fall of 1979, and updated in the fall of 1980. In addition, the most recent forecast prepared by APS was published in August 1980.

The projections shown in Table 3.4 of the Corps' report significantly overstate both the APS and the Power Plant Siting Program forecasts. The 1995 peak demand forecasts scenarios shown in that table are 12,900 MW, 9,000 MW, and 11,400MW. The first of these is cited as an APS forecast. The PPSP forecast for 1995 is for 8,928 MW, and the current APS forecast is for 9,220 MW.

We suggest that the Corps revise its tables and computations to reflect these forecasts. Copies of the PPSP forecast reports are available from this office.

Sincerely,

Randy Roig
Acting Director
PPSP

RR/ra

Enc.

NHS MAPS

Two maps are inserted into the adjacent pocket. One is an index map and one is a site location map. The primary purpose of the index map is to show the National Electric Reliability Council (NERC) regions, the Corps of Engineers division and district boundaries, and Corps office locations. A separate regional report and accompanying site location map has been prepared for each of the NERC regions depicted on the index map.

The second map shows existing and potential hydroelectric site locations for the subject region and is intended to provide general information to the reader about the sites. The size of a project is depicted by the diameter of the circle and the type of project by color. Each site symbol on the map is labeled with a four digit number which corresponds to a ten character National Hydroelectric Power Resources Study site identification code. Each part of the 10 character ID code helps to narrow down the source of information for that site. For example, a typical site identification code is shown below:

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            OR   A   NPP   9999
            |    |   |     |
   State ---+    |   |     +--- Site ID Number
Type of Project -+   +--- Corps Division and District
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Consequently, for more information about a site, one needs to determine from the map a site's state and county, the Corps division and district, and the four digit number. With the site ID number, the site can then be located in the list of sites in the regional report or in Volume XII of the NHS final report. If more detailed information is desired, the appropriate Corps division and/or district office may be contacted.

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NATIONAL HYDROELECTRIC POWER RESOURCES STUDY

INDEX TO NATIONAL ELECTRIC RELIABILITY COUNCIL REGIONS

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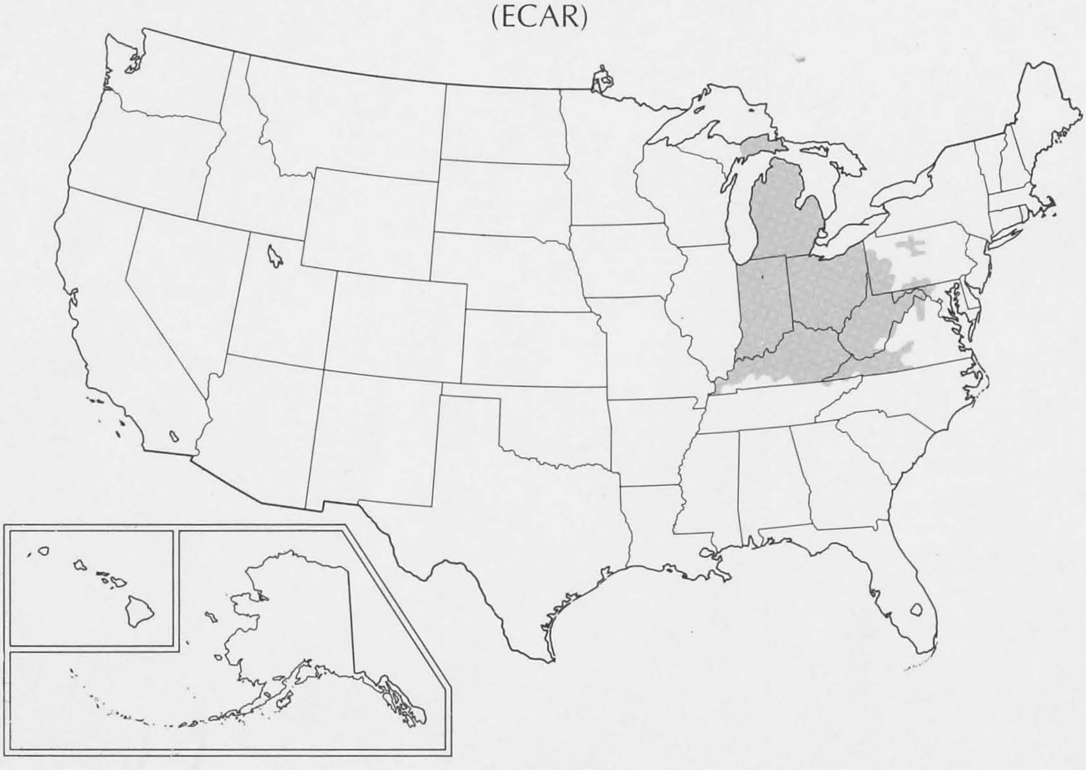
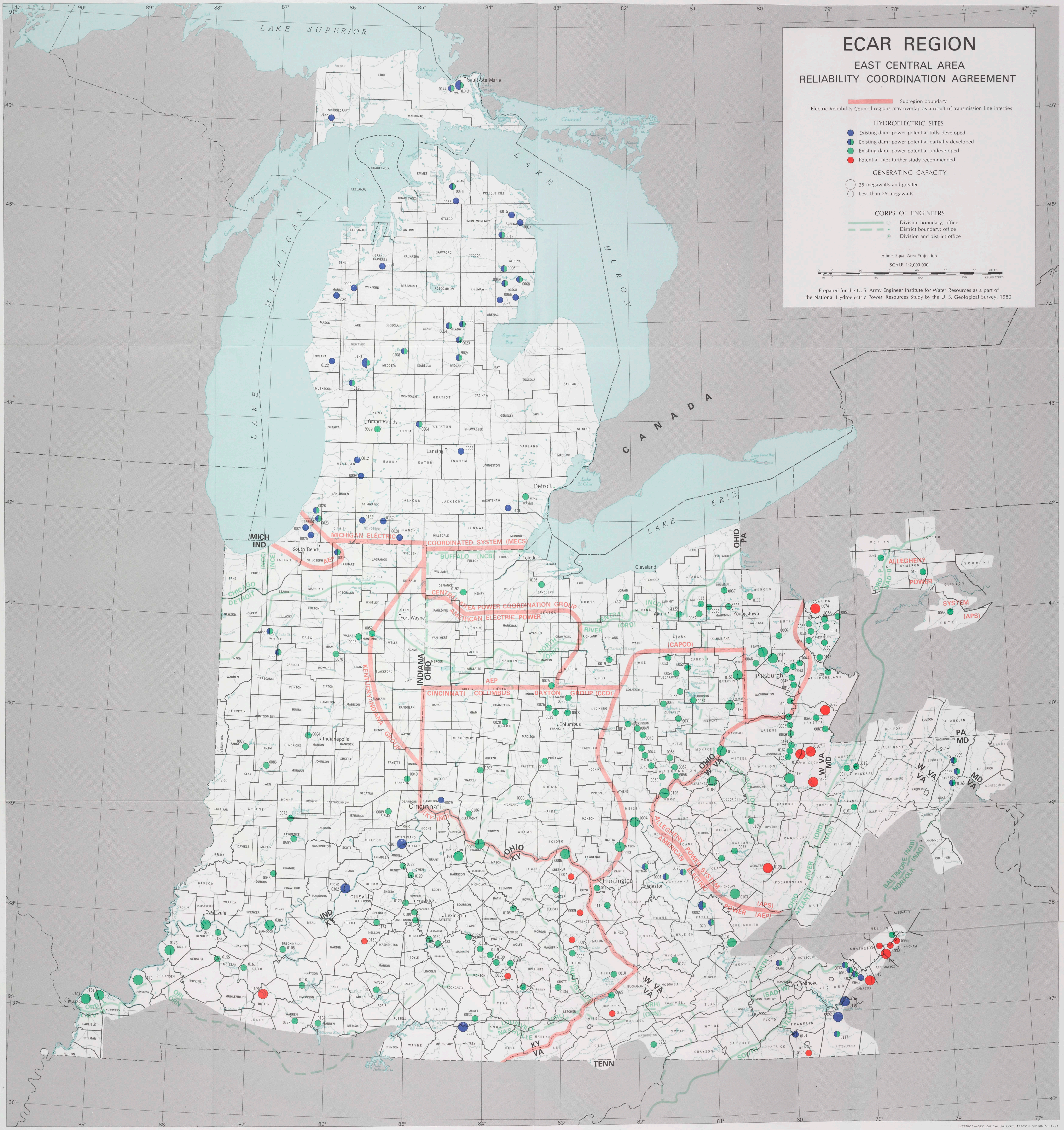
NATIONAL HYDROELECTRIC POWER RESOURCES STUDY

EAST CENTRAL AREA RELIABILITY COORDINATION AGREEMENT (ECAR)





INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1981

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